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No. 603

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CONTENTS PAGE

BULGARIA

ACHIEVEMENTS IN DEVELOPING HIGH-YIELD PLANT VARIETIES OUTLINED

Sofia SPISANIE NA BULGARSKATA AKADEMIYA NA NAUKITE in Bulgarian No 3, 1978 pp 5-10

[Article by Academician Khristo Daskalov: "Genetics and Selection Aiding the National Economy"]

[Text] The Appeal of the BCP Central Committee to the Bulgarian People for Developing a Nationwide Competition to Fulfill and Overfulfill the 1978 Plan and the Seventh Five-Year Plan states: "Of decisive significance for fulfilling the task posed by the 11th Party Congress for high efficiency and quality is a continuous rise in labor productivity based on the broad introduction of scientific and technical progress and upon a new organization of the production process. The task of all the people is a further development of agricultural production and raising its efficiency. The opportunities and reserves in this important sector are unlimited. At present it is decisive to utilize these reserves."

The modern seed varieties developed on the basis of the broad use of genetics as the theoretical basis of plant breeding are an important reserve and play an exceptionally great role in improving agricultural efficiency in raising labor productivity and reducing costs. It can be said that during the last decade our plant breeding based on genetics has made enormous progress and ranks among the leading members of world plant breeding. In a number of sectors of crop raising, our plant breeding holds a leading place in the world. In a competitive testing held last year by Lincoln University in Nebraska (United States), among 30 tested wheat varieties from 15 nations of the world, our varieties Yubileyna and Sadovo-1 were in first place in terms of the yield, and this was a great accomplishment for our nation. In bearing in mind that the new Bulgarian wheat varieties presently occupy around 80 percent of the land under wheat in Bulgaria, that is, around 7 million decares and that they produce a minimum of 8-10 percent of a higher yield than the Soviet varieties Bezostaya-1, Avrora and Kavkaz which were widely found in the past, one can see the great economic effect which is obtained from them. Each around 300 million kg of additional grain are obtained from the new wheat varieties and an economic effect of 17-20 million leva.

Bulgaria holds one of the leading places in the world also for the use of heterosis for vegetable crops and particularly for tomatoes. Our hybrid tomato varieties such as No 10xBizon, Triumf, Ogosta, Pioner-2 and others are widely used not only in Bulgaria but also in a number of other nations such as Yugoslavia, Romania, Czechoslovakia and elsewhere. It can be said that almost 100 percent of the early tomato production and 50 percent of the middle-early production in Bulgaria are based on our varieties. These varieties also bring a great economic effect.

The hybrid sugar beet varieties Poli E-1 and Poli E-d which are used to plant the entire sugar beet area in Bulgaria are in the front ranks of world sugar beet breeding and according to the data of the Ministry of Agriculture and Food Industry each year they produce an economic effect of over 1 million leva.

The tobacco varieties Nevrokop E-12 and Kharmanliyska Basma-162 are planted on a mass basis in Bulgaria and provide an economic effect also of over 1 million leva annually.

The cotton varieties Chirpan-433, Trakiya-2 (45-21) and P-73 which were developed at the Cotton Institute in Chirpan are used on a mass basis not only in Bulgaria, where the entire area is planted with them, but also in Yugoslavia and Greece. The economic effect from them has been calculated at around 4 million leva.

The hybrid corn varieties Knezha-2 L 611, Knezha-36 and others developed at the Corn Institute in Knezha equal the best hybrids in world plant breeding.

These are just a few examples which show the high level at which plant breeding exists in Bulgaria as well as the great economic effect which this brings our national economy.

It must be stressed that the major advances of our plant breeding are due primarily to the broad development of plant genetics in Bulgaria and the skillful use of genetic methods. Plant genetics has developed since the 1930's first at the Agronomic Faculty of Sofia University and the Central Farming Testing Institute in Sofia, where for a long time our prominent geneticist Academician Doncho Kostov worked, and after this at the Genetics and Plant Breeding Institute Under the BAN [Bulgarian Academy of Sciences] and in the sectorial breeding institutes which were large for our conditions such as the Wheat and Sunflower Institute in General Toshevo, the Corn Institute in Knezha, the Beet Institute in Tsarev Brod in the Shumen area, the Vegetable Crop Institute in Plovdiv, the Institute for Fruit Raising in Plovdiv, the Viticulture Institute in Pleven, and others. At these institutes sections and groups have been set up and are functioning and they work out genetic questions closely tied to the breeding of the corresponding crops. Crop genetics, as a theoretical basis of plant breeding, in relying on the rich experience of Soviet genetics and primarily the school of the prominent Soviet genecist Academician N. I. Vavilov, has

developed broadly and is playing a decisive role for furthering breeding work in Bulgaria on strictly scientific bases for the individual cultivated plants and for obtaining significant breeding results which have played and are playing an important role in intensifying our agriculture and raising its efficiency.

In speaking of plant genetics as the theoretical basis of modern plant breeding, we have in mind first of all the development of certain areas of genetics which at the present stage are of the greatest and most direct significance for the breeding of cultivated plants. These are primarily: Plant hybridization, the problems of remote hybridization, the surmounting of uncrossability and specific barriers, the morphogenetic processes with remote hybridization, and so forth having direct bearing upon solving the plant breeding problems. Hybridization, interspecific and intraspecific, is developing as the basic method in breeding cultivated plants. Over the last decade, research in the area of remote hybridization and the use of the great genetic potential of wild species have assumed great significance for breeding. In this area Soviet genetics has provided significant contributions in the works of N. V. Tsitsin, V. Pisarev, P. Zhukovskiy and others. Research on the inheriting of quantitative features has assumed particularly important significance recently in line with the development of modern varieties which possess comprehensively the most important features determining the quality of the varieties. Due to the results from genetic research on the quantitative features in plant breeding methods have been developed for creating modern varieties which combine the desired most favorable qualities. On the basis of hybridization, the best wheat varieties have been developed and these occupy over 80 percent of the wheat area in Bulgaria. These include Sadovo-1, Yubileyna, Levent, Ludogorka and others which we have already described, varieties of barley and cotton, well known grape varieties which are resistant to blight and cold, tobacco varieties which are resistant to powdery mildew and rust, and so forth.

It can be said that one of the major achievements in genetics in the 20th century has been the study and practical use of heterosis. The broad use of heterosis in plant breeding and commercial crossbreeding in livestock raising in recent decades is eloquent proof of the enormous role which genetic science plays in increasing the plant and animal products, and hence food for mankind. According to American data, by replacing the ordinary corn varieties with hybrid varieties obtained by using heterosis, each year the United States obtains over 19 billion kg of additional corn grain.

The general biological phenomenon of heterosis is characterized by greater vitality, by a more rapid rate of growth and development, by earlier maturity and greater productivity, by higher resistance to diseases and various unfavorable conditions, and by a more strongly expressed adaptation to the unfavorable conditions and manifested in the first generation after crossing. At the present stage, heterosis is widely used in the breeding of many cultivated plants as one of the most effective modern

breeding methods. At present this method is the strongest means for the rapid and sharp rise in the yields of crop raising and productiveness in livestock raising. Due to this, in all advanced nations intensive work is being carried out to explain the essence of this phenomenon and to make maximum use of it in the breeding of cultivated plants. Our nation stands in one of the first places in the world in the study of heterosis and particularly for widely using it in breeding. The Plant Genetics and Breeding Institute Under the BAN is the coordinator for the heterosis problem within the CEMA countries.

Heterosis is used in breeding some of the most important farm crops such as corn, sunflower, beet, tomatoes, tobacco and a number of other vegetable and feed grass crops.

On the basis of profound research and the use of heterosis Bulgaria has developed many valuable F_1 hybrids which are widely used in our agriculture and which play an important role in raising the yields and effectiveness of our crop raising. For example, for the most important feed grain crop, corn, valuable F_1 hybrids have been developed such as Knezha-2 L 611, Knezha-36 and Knezha-2 L 602. These are widely used in the nation and their potential for productiveness under irrigated conditions reaches up to 1,200-1,400 kg per decare. For sugar beets, the very valuable hybrids have been developed of Poli E-1 which is single-shoot and resistant to cercosporosis and Poli E-d which is multishoot and resistant to cercosporosis. At present the entire area under sugar beet in Bulgaria is planted with these hybrids. They have productive possibilities of from 3,800 to 7,900 kg per hectare of root crops with a high sugar content.

For tomatoes, as we have already mentioned, Bulgaria is high on the list in using heterosis. On the basis of the combined use of remote hybridization and heterosis, Bulgaria has developed and widely introduced into production a number of valuable F hybrids. It can be said that 100 percent of the early production and 50 percent of the medium early production of tomatoes in Bulgaria are planted with these hybrids. The potential productiveness of these hybrids reaches 8,000-12,000 kg per decare. These hybrids are of important significance in the exporting of fresh tomatoes abroad and for canning. For peppers, sunflower, tobacco and other crops, valuable F_1 hybrids have also been developed, and these are of important significance for our agriculture. In addition to the mentioned crops, there are also prospects for using heterosis with other important crops such as wheat, barley and others. At present intensive work is being done in this area both in Bulgaria and in other leading nations.

The concentration and specialization of agriculture have created conditions for the development of many diseases and pests which cause great losses in the crops. As is known, the chemicals for combating them also represent a certain danger for the health of man. Hence the great significance of genetic methods for combating the diseases of cultivated plants by developing varieties which are resistant to the diseases.

Both in Bulgaria as well as in the other leading nations, enormous research is being carried out to explain the genetic essence of plant resistance to individual pathogens and the genetic factors which determine resistance. In using the great genetic potential of wild forms as carriers of resistance and with the aid of remote hybridization, a number of varieties have been developed both in Bulgaria and abroad which are resistant to the most important diseases. For example, for resistance of wheat to rust and powdery mildew, for tobacco against blight and rust, for tomatoes completely resistant varieties to the most important diseases, for potatoes against most viral diseases, and so forth.

In this way, Bulgarian plant breeding, in using genetic methods, has developed many valuable disease-resistant varieties, and in this manner has helped to solve a basic problem in modern intensive agriculture, namely the replacing of chemical disease prevention by resistant varieties.

Experimental mutagenesis is an area of genetics which at present is widely used to develop valuable varieties. The essence of the mutation process, its control and direction presently represent one of the basic problems in genetics. Along with this, the use of experimental mutagenesis or the artificial causing of various types of mutants by exposure to ionizing radiation and chemical mutagens, represents at present one of the strongest means for creating genetic diversity and rich initial stock for plant breeding. In all nations of the world, including ours, experimental mutagenesis is widely being used to develop valuable varieties. The basic thing in using it in breeding is that by the mutating of individual genes which are the carriers of valuable qualities, it is possible to obtain varieties with valuable qualities, without involving the basic genotype of the initial variety, and this facilitates and accelerates breeding. In this way many varieties have been obtained which are resistant to various diseases. Up to now in world plant breeding, more than 100 varieties have been obtained by using experimental mutagenesis. We have also obtained valuable mutant forms of corn, wheat, vetch, beans, tomatoes, peppers and others which are of significance for breeding.

Polyploidy and aneoploidy are another direction in genetics which is widely used in developing modern varieties. For sugar beets, polyploidy combined with heterosis is widely used. The valuable sugar beet varieties obtained in Bulgaria, as has been mentioned above, have been developed on the basis of using this method.

For watermelons, triploid seedless watermelons have been developed and these are being employed in practice.

An important area in genetics which has direct bearing on breeding is aneoploidy, and this creates an opportunity to pass on individual genomes, chromosomes or parts of chromosomes from some varieties and forms to other ones. This creates real opportunities for the combining of valuable qualities. The method of substituting and adding alien chromosomes to a known species or variety is already being employed in plant breeding, particularly

in passing on genetic factors from wild species which cause high resistance to diseases and other important agricultural qualities.

Recently, so-called tissue cultures have widely been used in plant breeding. This is the artificial creation of entire plants, in proceeding from individual cells or a portion of the tissue, from the anthers, and so forth. The tissue culture method is successfully being used to obtain haploid plants and homozygous forms, for strengthening heterosis and for overcoming sterility in remote hybridization.

Modern plant breeding and the development of modern varieties which combine all the important qualities and meet the requirements of intensive agriculture require great and complex science. Plant genetics and breeding are inseparably connected. Without profound genetic research on which plant breeding can be based, at present serious plant breeding results are impossible. Only a close link between fundamental genetic research and the breeding research and the creation of breeding methods based on the newest achievements in modern genetics can lead to truly great breeding results, that is, to the development of varieties which meet the requirements of intensive socialist farming.

From this stems the necessity of a close tie of true and effective integration of the BAN institutes working on primarily fundamental problems of genetics with the sectorial breeding institutes of the Ministry of Agriculture and Food Industry which are directly concerned with the plant breeding problems.

In the nationwide upsurge to carry out the plan of the Seventh Five-Year Plan and the decisions of the 11th Party Congress, our genetics and plant breeding are taking their important place. The results in the area of plant breeding obtained on the basis of utilizing the theoretical achievements of genetics play an important role in the intensification of agriculture and in raising its efficiency.

We can be proud of the achievements of Bulgarian plant breeding. In many sectors of crop raising it is on a world level and provides results which rank in a leading place in the world.

We must further encourage and strengthen the development of genetics and plant breeding in our nation, and create conditions so that genetics and plant breeding in full interaction between themselves and relying on the most recent achievements in genetic science will produce even more valuable results thereby making their serious contribution to the nationwide struggle for raising efficiency in agriculture and for solving the general task of our party of raising the standard of living of the people.

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AMERICAN ANALOGUES OF SOVIET INTEGRATED CIRCUITS

Sofia RADIO, TELEVIZIYA, ELEKTRONIKA in Bulgarian No 6, 1978 pp 30-31

[Reference data]

[Text] Analogues of Soviet TTL Integrated Circuits Series K131

Soviet IC	Main functional purpose	Foreign IC Чуждестранни ИС									
		Texas Instruments	Fairchild	Motorola	National Semiconductor	Signetics	Sprague	Transitron	International Telephone and Telegraph	Teledyne	Raytheon
KILB 311	Two logic circuits 4I-NE	SN74H20N	9H20	MC74H20P	DM74H20	S74H20	US74H20A	TG74H20	ITT74H20	T104D1	74R20
KILB 312	Logic circuit 8I-NE	SN74H30N	9H30	MC74H30P	DM74H30	S74H30	US74H30A	TG74H30	ITT74H30	—	—
KILB 313	Four logic circuits 2I-NE	SN74H00N	9H00	MC74H00P	DM74H00	S74H00	US74H00A	TG74H00	ITT74H00	T102D1	74R00
KILB 314	Three logic circuits 3I-NE	SN74H10N	9H10	MC74H10P	DM74H10	S74H10	US74H10A	TG74H10	ITT74H10	T103D1	74R10
KILB 316	2 logic circuits 4I-NE with high output branching coefficient	SN74H40N	9H40	MC74H40P	DM74H40	S74H40	US74H40A	TG74H40	ITT74H40	T109D1	74R40
KILR 311	2 logic circuits 2I-2ILI-NE & 1 ILI expander	SN74H50N	9H50	MC74H50P	DM74H50	S74H50	US74H50A	TG74H50	ITT74H50	T105D1	—
KILR 313	logic circuit 2-2-2-3I-4ILI-NE with ILI expansion possibility	SN74H53N	9H53	MC74H53P	DM74H53	S74H53	US74H53A	TG74H53	ITT74H53	T108D1	—
KILR 314	Logic circuit 4-4I-2ILI-NE with ILI ex. poss.	SH74H55N	9H55	MC74H55P	DM74H55	S74H55	US74H55A	TG74H55	—	—	—
KILP 311	Two four-input ILI expanders	SN74H60N	9H60	MC74H60P	DM74H60	S74H60	US74H60A	TG74H60	ITT74H60	T106D1	—
KITK 311	J-K trigger	SN74H72N	9H72	MC74H72P	DM74H72	S74H72	US74H72A	TG74H72	ITT74H72	T101D1	—

Soviet IC	Main functional purpose	Foreign IC Чужестранные ИС										
		Texas Instruments	Fairchild	Motorola	National Semi-conductor	Signetics	Sprague	Transitron	Stewar Warner	Advanced Micro Devices	Sescosem	Mullard
KILB 331	Two logic circuits 4I-NE	SN5420S	9N20	MC5420P	DM7020	S5420	US7420A	TG5420	SW5420	—	SFC420PM	FJH112B
KILB 332	Logic circuit 8I-NE	SN5430S	9N30	MC5430P	DM7030	S5430	US5430A	TG5430	SW5430	—	SFC430PM	FJH102B
KILB 333	Four logic circuits 2I-NE	SN5400S	9N00	MC5400P	DM7000	S5400	US5400A	TG5400	SW5400	—	SFC400PM	FJH132B
KILB 334	Three logic circuits 3I-NE	SN5410S	9N10	MC5410P	DM7010	S5410	US5410A	TG5410	SW5410	—	SFC410PM	FJH122B
KILB 336	Two logic circuits 4I-NE with high output branching coefficient	SN5440S	9N40	MC5440P	DM7040	S5440	US5440A	TG5440	SW5440	—	SFC440PM	FJH142B
KILB 337	Two four-input circuits I-NE with open receiver & raised load capacity	SN5422S	—	—	—	—	—	—	—	—	—	—
KILB 338	Four two-input circuits I-NE with open receiver	SN5401S	9N01	ЦC5401	DM7001	S5401	US5401A	TG5401	SW5401	—	—	—
KILR 331	Two logic circuits 2I-2ILI-NE & over ILI expander	SN5450S	9N50	MC5450P	DM7050	S5450	US5450A	TG5450	SW5450	—	SFC45PM	FJH152B

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ANALOG INPUT OF URSADAT 4010 PROCESS INPUT-OUTPUT SYSTEM DESCRIBED

East Berlin MESSEN STEUERN REGELN in German Vol 21 No 6, Jun 78 pp 327-331

[Article by Dr H. Zimmermann, engineer, Institute for Regulation Technology at VEB KEAW, East Berlin-Treptow]

[Text] Introduction

The device system ursadat 4010 represents a link between the information input and output devices of the second process peripheral units and the process computer. It consists of function blocks for analog and digital information input and output.

Within the framework of the ursadat 4010 system, the analog input block (AE) serves to acquire analog measurement signals and to convert them into digital values. It is selected by the computer and it reports to the computer that the measured values have been digitalized. Resistance generators as well as other generators and measuring equipment with current or voltage outputs can be connected.

The analog input block comprises the analog input with relay connection AER-A and AER-B and the analog input with electronic connection AEE. The AER-A is designed for medium fast acquisition rates with higher accuracy or dependability; the AER-B is designed for medium fast acquisition rates with lower accuracy; and the AEE is designed for high acquisition rates.

These three basic variants are coordinated with respect to one another technically and constructively. Corresponding to user requirements, they therefore guarantee a flexible structure, combined with easy planning and servicing.

1. Structure and Mode of Operation

The AE block consists of the following functional units: measurement point changeover-connection unit (MUD), central amplifier (ZV), analog/digital converter (ADU), and measurement point changeover-control unit (MUS) (Figure 1).

The resistance generators as well as the other generators and measurement devices with current and voltage outputs provide analog signals, which the MUD converts into a voltage level suitable for further processing in the AE block. The AE block attenuates the push-pull noise voltages that are superposed on the measurement signal. When the respective measurement point is selected, the measurement signal goes to the central amplifier through a double-pole or triple-pole connection. The voltage at the output of the ZV is converted into a digital signal in the A/D (analog/digital) converter. The MUS provides block-internal control, and it communicats with the computer through the standard interface SI 2.2. The MUS and ADU are interconnected through a modified version of the SI 1.2.

The AER-A and AER-B blocks have an acquisition time of about 5 ms. Because this time is relatively long, these blocks communicate with the computer in PU (program interrupt) operation. The AEE block has an acquisition time of about 200 µs. By contrast, it communicates with the computer in the queuing mode.

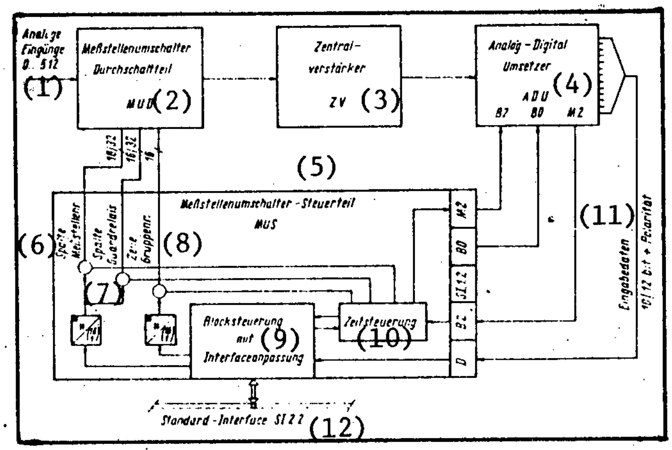
During a PU-mode input process with a computer, the requested measurement point address is stored in the buffer memory of the MUS, while the measurement value associated with the preceding address is accepted by the computer. When communication with the computer terminates, the computer switches through to the measurement point by means of the B1 signal. After the changeover time of the group switches and measuring point switches as well as the build-up time of the central amplifier have elapsed, the ADU is started by the MUS. When the ADU reports ready, the measurement point switch is opened, and a program interrupt signal PU is transmitted to the computer. In this way, the computer receives the information that the input process has been completed and that renewed traffic with the block is possible. After the traffic has been completed, the block cannot be addressed by the computer until the block has delivered a PU signal.

While an input process with the computer is taking place in the queuing mode with the AEE, the B2-signal of the computer immediately starts the block-internal control sequence in the MUS. Until the block reports ready (M1), the computer waits for the measurement quantity of the outputted address, before it agains switches off from the block by means of the B1-signal. The block-internal control sequence takes place as in the PU mode.

2. System Construction

Optimum user utilization of the analog input block involves accuracy, speed, and cost. This requires various modifications of the individual function units. These modifications of the function units are mutually exchangeable. In the simplest case, they represent equipment variants on a circuit board. By means of such modifications, the basic types of analog input AER-A, AER-B, and AEE can be constructed with little planning and production effort.

Figure 1: Block Circuit Diagram of the Analog Input



1. Analog inputs 0 . . . 512
2. Measurement point changeover switching unit MUD
3. Central amplifier ZV
4. Analog/digital converter ADU
5. Measurement point changeover control unit MUS
6. Column measurement point relay
7. Column guard relay
8. Row groups
9. Block control with interfacing matching
10. Timing control
11. Input data 10/12 bit + polarity
12. Standard interface SI 2.2

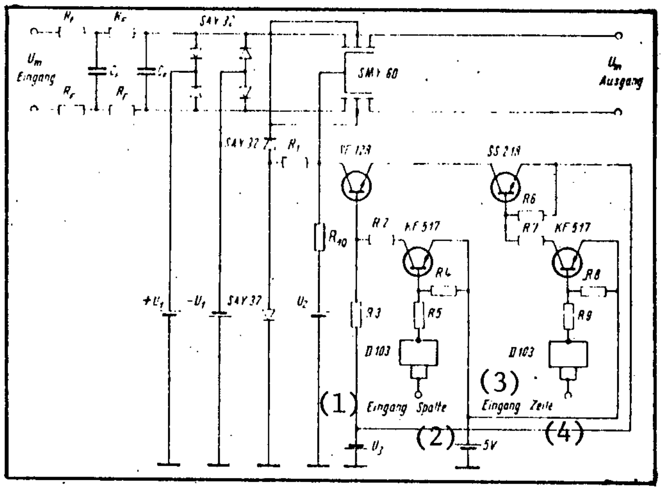
2.1 Measurement Point Converter-Switching Unit (MUD)

The purpose of the function unit MUD is to match signals, to suppress noise voltages, and to switch through the measurement signal.

The resistance generators, pick-ups, and measurement devices with current or voltage output emit signals. In the signal matching unit, these signals are converted into a voltage signal suitable for processing in the AE block. The conversion of the resistance changes of the resistance generators into corresponding voltage changes is implemented with bridge circuits. The conversion of current signals into appropriate voltage signals is implemented with matching resistors. Voltage signals are matched to the input level of the central amplifier by means of voltage dividers. A symmetric R-C filter is connected after the signal matching unit. This filter attenuates the push-pull noise voltage that is superimposed on the measurement signal.

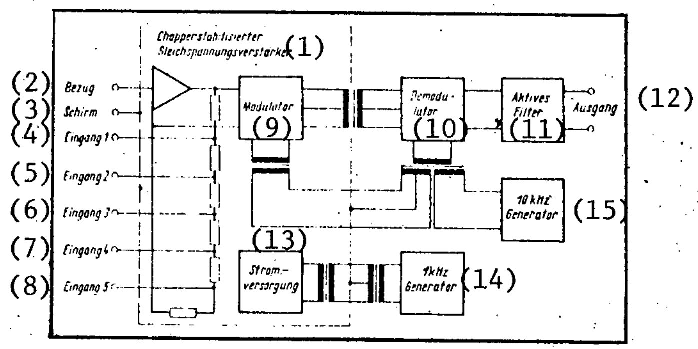
Three design variants are provided for switching through the measurement signal: a three-pole connection with sub-miniature gas-protected contact relays (AER-A), a two-pole connection with sub-miniature gas-protected contact relays (AER-A, AER-B), and an electronic connection with double-MOS-FET (AEE). The measurement points are here activated according to the column and row principle. Figure 2 shows the construction of a channel of the electronic connection, including its drive.

Figure 2: Electronic Through-Connection of a Channel with Drive



1. Input
2. Column
3. Input
4. Row

Figure 3: Basic Circuit Diagram of the Central Amplifier ZV III



1. Chopper-stabilized DC amplifier
2. Reference
3. Shield
4. Input 1
5. Input 2
6. Input 3
7. Input 4
8. Input 5
9. Modulator
10. Demodulator
11. Active filter
12. Output
13. Power supply
14. 1 kHz generator
15. 10 kHz generator

For high common mode rejection, a group switch is placed in series for each 16 measurement point switches. This DC group isolation of measurement points reduces the capacitive penetration of switched-off measurement points as well as the capacitive coupling between the measurement circuit and the system ground. Greater push-pull suppression is thereby achieved.

For service purposes, a test voltage component was developed for the MUD function unit. It offers very constant control voltages. In combination with a measurement signal through-connection component, this makes it possible to check the AE block for adherence to the fault category, or to check a measurement point for its functional capability.

2.2 Central Amplifier (ZV)

The purpose of the central amplifier is to match the bipolar symmetric measurement voltage, which is offered by the MUD, to the A/D converter level of 10 V, as well as to suppress its superposed common mode noise. Three types of amplifiers are available for this: the ZV III for the AER-A, the MV type 1619 for the AER-B, and the ZV IV for the AEE. The basic circuit diagram of the ZV III is shown in Figure 3.

In order to achieve the necessary common mode suppression and internal reliability, the input portion is DC-isolated from the output portion, and the input portion is completely shielded. The input signal is amplified to ± 3 V by a broad band DC amplifier. This amplifier is chopper-stabilized and has potentiometric negative feedback. Because of its negative feedback, it has a very high input resistance and a definite amplification. A potential isolating stage is connected to the output of this amplifier. This consists of an electronic two-way chopper, a broad band transmitter with shield windings between the primary and secondary windings, and an electronic two-way demodulator. The chopper frequency is 10 kHz.

An active filter with an amplification of V = 10/3 and 80 dB/decade attenuation is connected to the demodulator; this furnishes an output voltage of ± 10 V. The power required by the input is obtained from a 1 kHz squarewave voltage. This voltage reaches the input section through a series circuit of two repeaters. The return resistor has five taps. Depending on the connection, the measurement ranges 1 V, 200 mV, 50 mV, 20 mV, and 10 mV can thereby be optionally selected. By connecting the input shield to the ground of the measurement point, the input is capacitively isolated from the output. This achieves high common mode suppression.

The MV type 1619 amplifier was designed for applications with low requirements as regards accuracy and common mode suppression. It is constructed of three directly coupled integrated operational amplifiers of type MAA 502. Its inputs are current-compensated. It permits a maximum common mode voltage of 5 V, for which it has a common mode suppression of 80 dB. For higher common mode voltages, a diode protective circuit protects the amplifier from destruction. The amplification factor is permanently set at either ten or fifty.

In designing the central amplifier ZV IV for the AEE, not only speed problems but also DC isolation was of prime significance. The latter is an especially important requirement in medical technology. For this reason, an amplifier with DC isolation and alternating pulse transmission was developed.

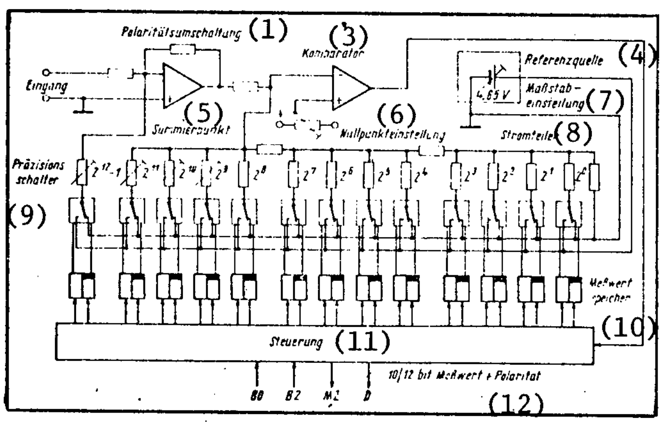
The amplified measurement signal is here transmitted in the form of pulses. Subsequently, the transmitting circuit is demagnitized by a counterpulse, through an internal polarity change of the input voltage. In this way, it is prepared for a new measurement. Appropriate equipment variants of the return resistors permit selection of 1 V and 200 mV measurement ranges.

2.3 Analog/Digital Converter (ADU)

The A/D converter transforms an analog input signal of -10 V . . . +10 V into a digital output signal in binary code, comprising ten bits or respectively twelve bits plus a sign bit. Three design variants can be selected: the ADU for the AER-A with a resolution of twelve bits and a conversion time of 165 µs; the ADU for the AER-B, with a resolution of ten bits and a conversion time of 165 µs, and the ADU for the AEE, with a resolution of ten bits and a conversion time of 50 µs.

The A/E converter is constructed as a step compensator with current summation. Its most important modules are the current divider with precision switches, the comparator, the reference source, the polarity stage, and the control with its memory for the measured quantity (Figure 4).

Figure 4: Basic Circuit Diagram of the Analog/Digital Converter



1. Polarity changeover
2. Input
3. Comparator
4. Reference source
5. Summation point
6. Null point adjustment
7. Scale adjustment
8. Current divider
9. Precision switch
10. Memory for measured quantity
11. Control
12. 10/12 bit measured quantity plus polarity

When the starting signal (B2) is applied, the conversion process is started. The memory for the measured quantity and the shift register of the control are reset. If the measurement voltage is positive, a negative voltage exists at the summation point, and no polarity changeover occurs. The control is

pulsed. With the AER-variants, the first BM of the memory for the measured quantity is set after about 12 µs. By means of the precision switch, the first evaluation resistor of the current divider is put at the reference voltage of + 4.65 V. This feeds a current into the summation point, which counteracts the current caused by the measurement voltage. Depending on the magnitude of the current, it corresponds to half the measurement range. After the first evaluation current has been switched in, if a voltage at the input of the comparator is still negative, the first BM of the memory for the measurement quantity remains set. With the next clock pulse, the second BM is set. This puts the second evaluation resistor of the current divider at 4.65 V. Since the A/D converter converts the measurement voltage into a binary code, half the current of the previous weight is fed in whenever another evaluation weight is connected. In all, ten or twelve weights can be connected. This results in an output signal range of the converter which extends from 0 . . . ± 1023 or respectively 0 . . . ± 4095, whereby 1,000 or respectively 4,000 digits on the output side are associated with an analog input voltage of 10 V.

If the connection of a weight yields an accumulated compensation current which is larger than the current caused at the summation point by the measurement voltage, the last connected weight is agains removed. In this way, at the end of the conversion cycle, the measured quantity is present in binary code in the memory for the measured quantity.

If the measurement voltage is negative, the positive voltage exists at the summation point at the beginning of the conversion cycle. This sets the polarity BM, and a counter-current is fed into the summation point through the polarity stage. This current corresponds to the full measurement range. Conversion can then begin in the manner described above. With a negative measurement quantity, feeding in the counter-current yields the complementary digital value in the memory for the measurement quantity. When the A/D converter reports ready (M2), the digital measurement quantity is available at the output of the A/D converter until the next start (B2).

2.4 Measurement Point Changeover Control Unit (MUS)

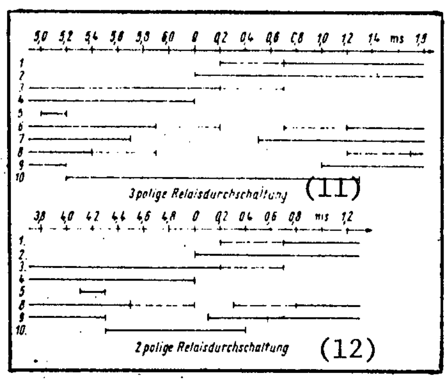
The MUS function unit has the purpose of implementing communication with the computer through the standard interface SI 2.2, and of guaranteeing block-internal control.

It is constructed of the following modules: block control for line traffic with interface matching (BSL), the time control, the decoder, and the row and column amplifiers. The BSL organizes communication with the computer. Through the address bus, it receives the block- and measurement point address. After the working cycle of the block, it makes available to the computer an appropriate digital measurement quantity on the data bus.

The measurement point address is here first put into intermediate storage. Subsequently, the column and line decade are separately decoded in a one-out-of-16-code decoder. The column and row signals, which are obtained in

this manner, are then prepared in the column and row amplifiers for the through-connection of the measurement point switches. Three design variants of the row and column amplifiers are provided, one variant for the relay through-connection of the AER-A and AER-B, one variant with optocouplers for the AER-A, with especially high requirements for common mode suppression, and one variant for electronic through-connection of the AEE. The time control of the MUS organizes the block-internal control. After the block is started, the measurement point is first switched through. After the operating time of the measurement point changeover unit and the build-up time of the central amplifier have elapsed, the ADU is started. When it reports ready, the measurement point is switched off, and the ready signal is delivered to the computer. In implementing the timing sequence, special consideration must be given to the tolerances of the triggering and drop-out times of the relays, so that different measurement point addresses do not briefly overlap, and so that, in the interest of high common mode suppression, the guard is switched in before the measurement lines and switched out after them. The timing diagrams for the double pole and triple pole relay through-connection of the AER-A are shown in Figure 5. The time control is pulsed. It is constructed of a counter with a connected selection logic. The counter is fed from a quartz-stabilized generator with a frequency of 1.28 mHz. A variant of the time control is available for the AER-A and AER-B, and another variant for the AEE.

Figure 5: Timing Diagram for the AER-A

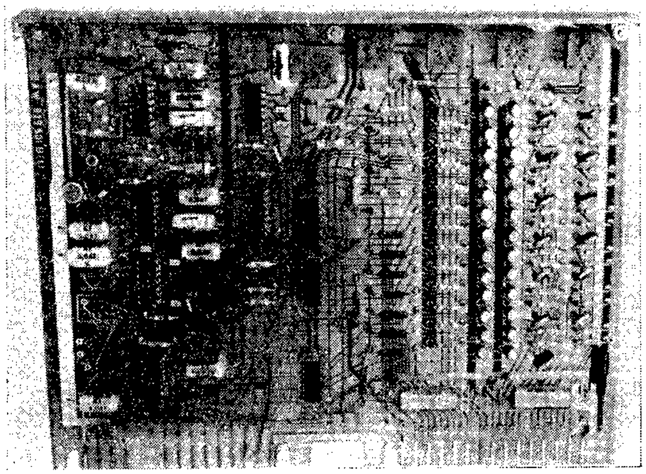


1. Contact group relay cycle n + 1
2. Excitation group relay cycle n + 1
3. Contact group relay cycle n
4. Excitation group relay cycle n
5. A/D conversion
6. Contact measurement point guard relay
7. Excitation measurement point guard relay
8. Contact measurement point relay
9. Excitation measurement point relay
10. Short circuit or input line of the ZV
11. Triple pole relay connection
12. Double pole relay connection

3. Physical Construction

The analog input block is constructed as a component of the device system ursadat 4010, from parts of the uniform container system (EGS). The smallest constructive units are card inserts with dimensions 20 mm x 95 mm x 170 mm and 20 mm x 215 mm x 170 mm, and block components which are equipped with TTL integrated circuits as well as with discrete components (Figure 6).

Figure 6: Ursadat 4010 Card Insert A/D Converter System Component



The card inserts are housed in cassettes, which consist of module supports and of wiring frames on their backsides. The card inserts are connected to 58-pole direct plug connectors. For connecting the process cables, 26-pole indirect plug connectors can alternatively be used. The wiring is designed as wrap wiring.

Five different types of cassettes have been developed for the AE block. By means of these, all possible project variants can be constructed (AE power supply cassette, AE basic cassette, AE supplementary cassette 1, AE supplementary cassette 2, AE supplementary cassette 3).

The AE power supply cassette is 120 mm high; all other cassettes are 240 mm high.

Certain components of an AE block are project-independent. Among these always belong the AE-power supply cassette and the AE basic cassette. The components arranged in the AE power supply cassette furnish the supply voltages required for operating the block. The AE basic cassette contains the function units MUS, ADU, parts of the MUD, with connection possibilities for 48 measurement points. In the design variant of the AER-B, it also contains the ZV, and the group switch belonging to the MUD. In the design variant of the AER-A as well as of the AEE, the AE supplementary cassette 1 accepts the central

amplifier and the corresponding group switches of the MUD. The AE supplementary cassette 2 serves exclusively to accept 24 MUD matching components, whereby four channels are always housed on one component. The AE supplementary cassette 3 serves exclusively to accept the preamplifiers, with connection possibilities for twelve measurement points (signal level 50 mV).

For accepting the cassettes, the cabinets have appropriate swivel frames (Figures 7 and 8). The design variants of the AER-A can be equipped for at most 512 measurement points, and those of the AER-B and AEE for 256 measurement points.

Figure 7: Ursadat 4010 Swivel Frame with AER-A and AEE, Equipment Side

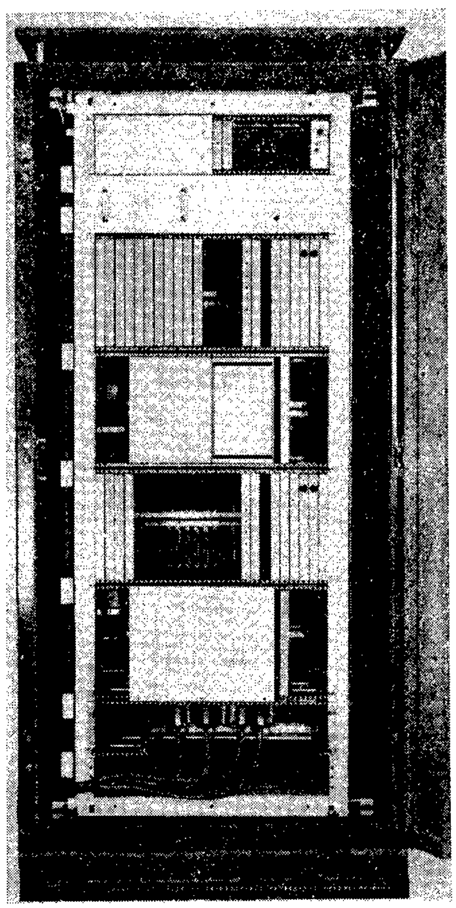
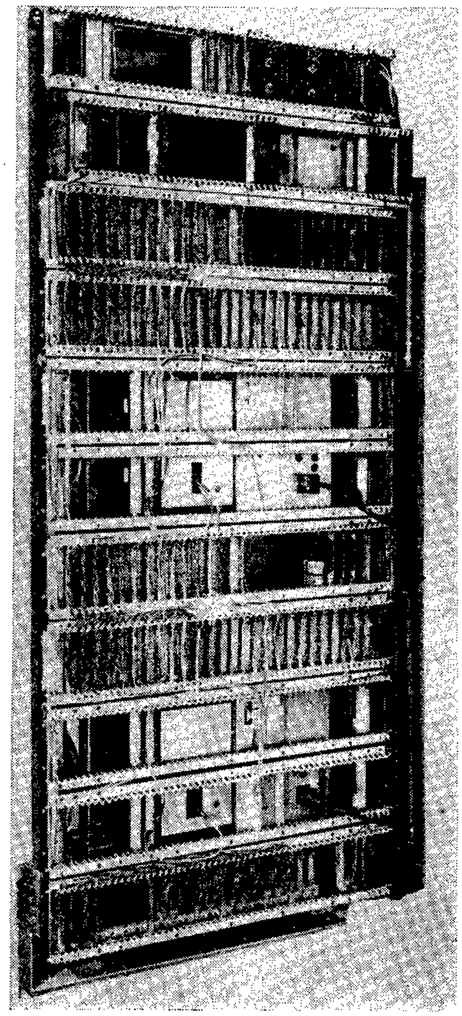


Figure 8: Ursadat 4010 Swivel Frame with AER-A and AEE, Wiring Side



4. Technical Data of the Analog Input

Parameter	AER-A	AER-B	AEE
Eingangs- größen: (1)			
Strom (2)	−5... +5 mA −10... +10 mA −20... +20 mA 1... 5 mA 2... 10 mA 4... 20 mA	−5... +5 mA −10... +10 mA −20... +20 mA 1... 5 mA 2... 10 mA 4... 20 mA	−5... +5 mA −10... +10 mA −20... +20 mA 1... 5 mA 2... 10 mA 4... 20 mA
Spannung (3)	−10... +10 V −1... +1 V −200... +200 mV −50... +50 mV −20... +20 mV −10... +10 mV	−10... +10 V −1... +1 V −200... +200 mV	−10... +10 V −1... +1 V −200... +200 mV
(4)	mit Vorverstärker, außerdem −40... +40 mV −30... +30 mV	mit Vorverstärker, außerdem −50... +50 mV −40... +40 mV −30... +30 mV −20... +20 mV −10... +10 mV	mit Vorverstärker, außerdem −50... +50 mV −40... +40 mV −30... +30 mV −20... +20 mV −10... +10 mV

1. Input quantity
2. Current
3. Voltage
4. With preamplifier, furthermore

Resistance thermometer:	Pt 100 according to TGL 0-43760; measurement ranges according to TGL 0-43709: -30 . . . +60 °C, 0 . . . 60 °C, 0 . . . 100 °C, 50 . . . 150 °C, 0 . . . 300 °C, 200 . . . 400 °C, 300 . . . 550 °C
Remote resistance generator:	Remote unit generator type F 16.0 NA (starting resistance 10 ohms ± 3%; alteration range 100 ohms, total resistance 120 ohms ± 0.5%)
Generator connection:	Voltage and current generator in double line circuit; resistance thermometer in double or triple line circuit
Maximum length of measurement lines:	Current generator : 5000 m Voltage and resistance generator : 500 m

Parameter	AER-A	AER-B	AEE
Ex-protection	Internal safety according to TGL 19491 page 6 can be guaranteed	Not guaranteed	Not guaranteed
Output quantities	12 bit binary coded 1 bit polarity	10 bit binary coded 1 bit polarity	10 bit binary coded 1 bit polarity
Through-connection	Double pole and/or triple pole	Double pole	Double pole
Scanning rate	Double pole 200 measurement point/s Triple pole or double and triple pole: 170 measurement point/s	200 measurement point/s	5000 measurement point/s
Maximum scanning rate of a measurement point	1 measurement point/s	1 measurement point/s	5000 measurement point/s
Capacity	In steps of 4 measurement points up to 256 measurement points in single block operation, or respectively up to 512 measurement points in double block operation	In steps of 4 measurement points up to 256 measurement points	In steps of 4 measurement points up to 256 measurement points
Fault category	1. With measurement circuits which are not self-fused, with resistance generators as well as current and voltage signal generators having a signal level $\geqq$ 200 mV: 0.25	0.4	1. With a signal level $\geqq$ 1 V: 0.4 2. With resistance generators as well as current and voltage signal generators having a signal level $<$ 1 V: 0.6

Parameter	AER-A	AER-B	AEE
	2. With self-fused measurement circuits in general and with non self-fused measurement circuits having a signal level 200 mV: 0.4		
Temperature error	0.25%/10 K	0.25%/10K	1 x fault category/10K
Push-pull attenuation for f = 50 Hz	40 dB	40 dB	Project-dependent 0 or 20 dB
Common mode suppression for 0 . . . 50 Hz and 1 k ohm asymmetry	110 dB	80 dB	90 dB
Maximum common mode voltage	For non self-fused designs: 300 Vs, with self-fused designs: 60 Vs	5 Vs	5 Vs
Overload protection for common mode voltages		Up to 60 Vs	Up to 60 Vs

8348
CSO: 2302

POLAND

BRIEFS

NEW SORBING AGENT--A technology for the production of a high grade sorbent for sulphur dioxide and other acid gasses is under development at the Main Institute of Mining in cooperation with the Hajnowka Destructive Wood Distillation Research Laboratory. The new sorbent has expanded application parameters in comparison with the sorbent now produced. AHD-2 active carbon has been used as the absorptive medium. The medium was obtained in the form of granules from Type 34 hard coal and prepared wood tar. The medium was then saturated with a solution of sodium carbonate and potassium. Due to this, the normal chemical reaction takes place between the alkaline compound salts and the absorbed gasses. The new sorbent is an improvement with regard to the length of protection against chlorine and sulphur dioxide. Its mechanical properties are also good. [Text] [Warsaw PRZEGLAD OBRONY CYWILNEJ in Polish No 7, Jul 78 p 58]

CSO: 2600

YUGOSLAV SCIENCE POLICY DEFINED

Belgrade TEHNIKA in Serbo-Croatian Nos 6, 7-8, 1978

[Position paper issued by the League of Republic and Provincial Self-Managed Special-Interest Communities for Scientific Activities in Yugoslavia: "Bases for Science Policy in the SFRY"]

[No 6, 1978, pp 857-866]

[Text] Consistent with the intention of the journal TEHNIKA to nurture and guide scientific research work in Yugoslav work organizations, in this issue and the one to follow we will publish the text of the document entitled "Bases of Science Policy in the SFRY" issued by the League of Republic and Provincial Self-Managed Special-Interest Communities for Scientific Activities in Yugoslavia. We expect that these two installments will be of considerable benefit and that they will also stimulate development of a discussion which will facilitate fruitful implementation of the science policy which has been adopted as well as the preparation for defining the elements of science policy for the upcoming planning period.

Basic Outline of Science Policy

1. Science in Contemporary Society

1.1. Basic Characteristics of Science's Position in Society

There are two characteristic aspects of science's position in contemporary society:

first, the present scientific-technical revolution is all-inclusive in its nature by contrast with previous partial inroads of science into particular spheres of the activity of society. The most recent changes in the production base and social structure of the modern economy have already imparted new attributes which necessarily require corresponding changes in the line of development and in the organizational structure of scientific activity;

second, science is not, nor can it be, turned exclusively toward the technological factor. The most recent trends in scientific activity indicate that research work must be concerned with all aspects of the development of society. This viewpoint gives science a more complex and meaningful function--it has a share in shaping the necessary material, technical, social and other elements of society which can satisfy the individual in society and guarantee that society as a whole is developing toward the goals which have been defined.

Science is not an abstract category, just as science itself cannot be abstractly defined: science is society's response to the challenge of specific historical development and can therefore be regarded as a necessary reflection of the material and institutional framework of the community in which it is developing. The most recent trends in scientific development show that in specific societies the pace of science is faster when it is oriented more toward the goals of those societies' development and that, conversely, societies develop faster when their overall development and its goals are placed on a scientific foundation and when the results of scientific research are used in practice.

A study of the relationship between science and society must focus concretely on the problem area of the relationship between Yugoslav science and Yugoslav society which is organized on the basis of self-management. Only if this kind of approach is taken to this analytical assignment is it possible to shape definite elements for elaboration of science policy in the Socialist Federal Republic of Yugoslavia.

The essence of self-management is manifested above all in the humanization of production and other social relations, in the integration of the production functions and the functions of management, in the unceasing strengthening of the material base of the self-managed society as the foundation for freer and more integrated development of every workingman, and in the creation of conditions for inclusion of every individual both in organized creative work based on association and also in the processes of managing that work and governing society as a whole. Self-management is a dynamic process--it goes beyond a formalized social relationship, and depends above all on the real development of social relations and the productive forces of society, which, subordinated to the interests of human development, create the social basis for man's true development.

The division of labor and modern organization of social processes based on it call upon science both to establish and organize those processes and also to guide and control them. In performing this role science becomes a productive force in and of itself, and as such creates the historical possibility of overcoming the traditional division between mental and physical labor and between making policy and carrying it out. Along the same line, self-management, permeated throughout by science, creates the possibility for the first time in history of abolishing the division into managers and operatives. This leads to what Marx calls "the collective combined laborer,"

toward integration of the manual and mental elements, which intertwine in associated labor. Self-management and science, then, figure as an inseparable tandem at all levels of social combinations of work and the activities of society.

The basic characteristics of science's status and development in Yugoslav society are to be seen, first, in the fact that scientific activity has become and is becoming more and more an integral part of self-managed associated labor and is directly linked to and integrated with the economy and other activities of society. In this manner self-managed associated labor stands as the basic factor in establishing the goals and programs for the development of scientific research, and through the subsequent process of discussion and agreement through the mechanism of self-management the development of that activity is guided in conformity with the overall goals of social development at the levels of the republics, the provinces and the entire country.

As we use it, the term "scientific research" covers research proper, scientific application and experimental development [R&D].

This understanding of the relation between scientific research and Yugoslavia's self-managed society implies that a more detailed analysis must be made of the functional connection between science and the various parts of the self-managed social system, in particular an analysis of the following:

a) the role of R&D in basic organizations and associations of associated labor;

b) science's role as a cohesive force of self-managed associations;

c) the place of R&D in development processes and planning of society as a whole and the economy;

d) science's role in education, culture and all other nonproductive spheres in the life of society and individuals;

e) the task of science in developing science itself, in bringing science closer to the real directions of life and society, to its practical application in production, in commerce and in other spheres of the activity of the economy and society;

f) the role of science in the political and defense function of a society organized on the basis of self-management.

1.2. Science as an Instrument in Development of Organizations of Associated Labor

Scientific research should furnish industrial, agricultural and other organizations of associated labor in our country a guarantee that they are

adopting optimum development programs, that in their everyday practice and behavior they are receiving comprehensive information on a scientifically reliable basis, that they are stimulating proposals that will improve efficiency, production innovations and invention, and that by applying the achievements of science in practice they are achieving progressive development in self-management relations and in utilization of the productive resources available. The ever greater linkage between science and associated labor will be especially manifested in the following:

i. in the application of scientific methods in programming lines of development and the organization of production within enterprises;

ii. in scientific analysis of the social role of enterprises and in investigation of the impact on the natural and social environment (the enterprise's social balance sheet);

iii. in the systematic organization of research activities at all work stations where creative elements might arise;

iv. in the shaping of criteria to be used in selective introduction of innovations, in diversification of production and in standardization of production to meet the human measure;

v. in the scientific adoption of plans for professional training of personnel;

vi. in the scientific shaping of a comprehensive information service with vertical connections to appropriate information centers, which is indispensable to dynamic development of the modern enterprise.

The entry of science as a system and as organizational principles governing operation into the basic cell of associated labor is, then, an indispensable condition to a faster pace and greater efficiency in the future functioning of our economy and to more comprehensive development of the self-managed social organism. The autonomy of the cell does not signify negation of the integrity of the whole, but is on the contrary a condition for formation of organic associations on new foundations and for transition from autarkic and partial self-management in enterprises to the system of self-management through the entire society.

1.3. Science as an Element in Integration of the Economy

The application of science in production and in the monitoring and management of processes is possible only in an integrated economy with modern organization, one which is able to afford the high costs of research and development and of supporting its diversity. At the same time, under modern conditions this kind of production can be organized only if scientific methods are applied, which means that the entry of science signifies a tendency toward economic integration.

That tendency does not run counter to the tendency toward autonomy of the basic cells of associated labor, but is its complement; it should be understood as an historically new type of integration (associative), which is not achieved through monopolization nor centralization; it is based on coordination of the interests of the producers and therefore does not amount to "takeovers" of smaller enterprises by large ones, but is a linkage based throughout on conclusion of agreements in the search for better organization, better placement of the products of labor and a more equal share in division of the social product. The production associations formed by that integration will in turn create new conditions for development of organized research and development. The reasons for its low effectiveness at the present time, its extensive development and the feebleness of innovative activities do not lie solely in the economy's fragmentary structure, not in the shortcomings of its personnel, nor in its lack of financial strength. It is a fact that those who today dispose of the principal portion of the social accumulation (the banks and trade) still stand outside integrative processes as intermediaries of a sort between production enterprises and society as a whole and therefore have usually no incentive to invest in research. The broader processes of integration which should bring about large integrated complexes in the economy will also concentrate in them the resources for long-range R&D programs.

Economic integration is creating new conditions for the organization of research and development and for orientation toward the vital problems in the development of society as a whole. Scientific research is thus becoming an integral part of self-managed associated labor in the economy and in social services, while self-managed associated labor is becoming the principal participant in establishment of the goals and programs for development of research and development and in providing the material basis for developing those activities.

Optimums of new production systems and of the appropriate methods and organizational structure for their efficient operation will have to be defined on a scientific basis. Moreover, the orientation of research and development toward the developmental and other needs of associated labor will bring about a speedy return of the funds being allocated to research today and will thereby initiate more rapid growth in a spiral consisting of production, research and development, and society as a whole.

1.4. Science's Place in Social Planning

Science policy is an integral part of overall public policy and in no case can it become an end in itself. Associated in basic organizations of associated labor, the producers are to direct it toward the key problems in development both of each individual production organization and also of every particular activity of society and of society as a whole. But science policy takes on its full value and justification only in the context of general policy, which gives it the necessary attributes for adoption and use on a broad basis: by industry, the universities, the social planners and all

other participants in the activities of the economy and society. It is in this context that the place and role of science in the process of social forecasting and planning must be appraised.

The limits of the kind of development that took shape in the period of industrialization and whose form of social organization is the consumer society are today becoming more and more distinct. Those limits--destruction of the natural environment, the shortage of basic raw materials (fuels, metals, and even clean water and air), the extent of the population explosion, the untenability of the division of the world into abundance on the one hand and a struggle for survival on the other--have today moved to within arm's reach, confronting us with a decision: to substitute for the direction of reckless industrial development pursued up to now by a scientifically grounded model of development and of the humanization of society. Science should have one of the most important roles in constructing that model and in planning and organizing all the processes of society.

The new meaning and role of the system of self-management and social planning are set forth in the Resolution of the 10th LCY Congress, which states that planning must be simultaneously developed in basic and other organizations of associated labor, in opstinas, provinces, republics and the Federation, which makes it necessary to achieve consistency among plans and development programs, the points of departure being the interest of every self-managed community and common interests as set forth and pursued by the overall development policy of the entire SFRY. The resolution especially stresses that planning must be based on scientific knowledge, which clearly defines science's place and role in self-management planning and social planning.

The extensive vertical and horizontal structure of associated labor, in all its abundant associated forms, in and of itself points up the need for intensive inclusion of organized knowledge in all the pores of this new social organism which has just come into being. Since the possibility of all domination and subjugation is eliminated in that new system, science also is given broad room for becoming an active and irreplaceable participant in social planning and decisionmaking. Then there is another circumstance which should be borne in mind. Scientific research and innovation are based to a maximum degree on education, and the latter is a reflection of an entire chain of material, cultural, sociological and other conditions in our society. Empirical analyses of the recent period in the world and in Yugoslavia show that R&D and education are more and more becoming the principal factors in economic development, while investments (which such a fetish is made of even today) take on meaning only in combination with these factors.

1.5. The Role of the Sciences in the Sphere of the Social Superstructure

A self-managed society is a cooperative association which is based on the relations of free and equal cooperation among people. The very term "associated labor" points to voluntary cooperation among people as a lasting social process.

If we define self-management as "the way of life in free and equal associated labor," it follows that it is actually a separate sociocultural system, one that differs in its essential characteristics from all other sociocultural systems in the present and the past. By developing its own values, criteria and standards of measurement, our self-managed social organism must necessarily incorporate science in an active way in order to scientifically define and predict the course and development of such human values as the following: solidarity, equality, collective decisionmaking (in the political and economic spheres), education, health, culture, and environmental protection.

In every society which is developing at a fast pace there occurs a high differentiation of the social structure, and complex problems arise in connection with that process. At the same time, in the course of that process the social structure undergoes unceasing changes coming primarily from the economic and technical sphere. The changes and the need for rapid adaptation follow one another at an ever faster pace. These two factors--the high complexity of the social structure and the ever faster pace of social changes--are deep sources of conflicts which even a self-managed society cannot avoid. However, in a self-managed society the conflicts arise openly, and they must be resolved openly with the understanding that this is the dialectics of growth. Science has an important role to play here. So, in the sphere of the social superstructure of a socialist self-managed society science is a permanent factor in establishing the real elements of the present and in forecasting optimum solutions for the future.

1.6. Science Policy and the Science of Science

It follows necessarily from analyses that have been made and past discussions that science is one of the fundamental components in development of a self-managed society. Consistent with that, a self-managed society must have its own science policy, but that must be a policy differing essentially from the science policies of other social systems in its structure, its organization and its methods of functioning. In a self-managed society science policy is not and cannot be "government science policy." It can only be aims and tasks arrived at and coordinated on a self-management basis which science, as an incorporated factor in the organism of social self-management, is to study and perform, motivated principally by the optimum development of the individual, of the self-managed units and of the self-managed society as a whole.

In the endeavor to find realistic optimum solutions in every specific research undertaking, science in a self-managed society becomes an important factor for integration, one which will be more able than all other factors to offer resistance to those unscientific tendencies which are trying on the basis of certain particularistic and other interests to divert the lines of development of self-management and to slow down those processes at the level of the national economy as a whole which are the objective reflection of certain immutable developments. That science policy of a self-managed society is formulated through a coordination and integration of the interests of

producers associated within the basic cells of associated labor, and it is at the same time derived from the general goals of our society's development. The special-interest communities for scientific activity in the republics and provinces, where the interests of all the working people confront one another on an equal footing, are an important place for formulating that policy. Joint science policy in Yugoslavia is created as one of the most important components in the overall development of our self-managed sociopolitical community by linking up and coordinating those national projections and programs of scientific development with the role of scientific research in other social services.

The science of science, which is the theoretical and methodological basis for rational guidance and organization of science, contributes to the systematic creation of that policy.

2. The Political-Ideological Aspects of Science

2.1. Basic Political-Ideological Criteria of Science Policy

The political-ideological criteria of science policy follow from all those premises on which the new socialist self-managed society is shaped and in which the dominant issues are issues like these: issues concerning the work and life of the workers and other working people; raising labor productivity and augmenting income and creating a more abundant material base of society; abolishing the remnants of wage relations and of the workers' alienation from the results of work; strengthening the worker's material and social security; more effective resolution of the problems of employment and a more balanced development of the productive forces; raising the level of general culture, education, technical sophistication, health standards and physical education, as well as all other issues related to the progressive development of society, of the working people, and of the relations of self-management which are conducive to that progress.

It also follows therefrom that closer cooperation and coordination need to be established in the programming and developing of scientific activities at the level of the entire country if scientific work is to be organized more competently and rationally. This necessitates that scientific institutions and the creative forces in our science be so organized and guided that they will guarantee uninterrupted study of the basic problems, patterns and contradictions of our social, economic and technological development, the principal purpose here being to speed up the formation of science's links with real social development and also formation of theory's links with socialist self-management practice and the development of Marxist social thought.

By its very nature science develops by virtue of long-term processes, but also in leaps, governed in this by certain specific laws, but at the same time it also develops as a subsystem that is closely bound up with the other subsystems of society. Clearly science cannot be merely the interpreter of what has been given or the critic of the entire status quo; it must above

all contribute to the changing of relations, to the changing of the conditions of life. Herein lies the essence of its humanistic role and mission. Science must link up only with the most progressive tendencies in social practice. There is also a need for continued ideological support of its progressive orientation, since this is an essential element in its development and in its impact on social practice.

It is of great importance to discover the causes of various occasional flareups which might be called conflicts between politics and science. The causes should be sought both in politics and also in science. But it is not just a question of discovering the causes, but above all of creating conditions for the most balanced and effective cooperation in which those conflicts are resolved. We need to oppose tendencies aimed at creating an atmosphere of a continuous conflict in principle between science on the one hand and ideology on the other. Science cannot altogether replace ideology in resolving the contradictions of society and in opening up the pathways for social progress. Science must provide analyses which will contain an objective picture of society, must reveal the source and extent of its internal contradictions, and must offer a possible choice of directions for activity and development.

For small peoples a rational R&D policy is of much greater importance than even for large nations, since in the smaller countries a number of factors are lacking (mobility of personnel, competitiveness in research work) that exist in the large communities and which spontaneously open up and stimulate development. These developmental thrusts must be made up for in Yugoslavia by virtue of a very deliberate system for encouraging and guiding research work.

In setting the goals of science policy we must not forget that in the effort for Yugoslavia to catch up with the technologically more advanced world, conditions are at the same time for the new contradictions and crises which are arising in the advanced communities: the contradictions between the aspirations of democratic humanism and the concentration of economic and political power, between the advanced and the underdeveloped, crises caused by the militarization of society, ecological crises, and so on. There will be a need, then, both at the level of society and also at the level of science policy, for measures to be taken to resolve those contradictions and crises. The first thing should be to study the science policy of the technologically advanced countries and the mutual relation between the elements of that policy and difficulties in the development of those countries.

In conclusion we should state that the basic standard of measurement of the social progressiveness of research work must be its results that contribute to overall social progress and to attainment of the historical goals of the working class.

2.2. The Scientific and Technological Revolution in a Self-Managed Socialist Society

Science is penetrating all the pores of social life and is constantly giving new dimensions to society's development. Whereas up to now every generation has in large part taken over from its ancestors the conditions for its activity and manner of life, while those conditions were determinant throughout the entire period of their life, in future we must assume that every generation will in the course of its own life alter some assumptions of their civilization, perhaps even essential ones. The exceptional pace, scope and depth of the revolutions in production, in technological innovations and in scientific discoveries in the world are making us aware that processes are beginning to take place which are altering the structure of the productive forces and the material foundation of human life in general to their foundations and which belong among the greatest revolutions in the course of civilization. The further the development of the scientific and technological revolution, the more necessary it will be to develop creative spiritual potential so as to overcome the new dimensions of human activity and adapt to the generally new aspects of life.

The Resolution of the 10th LCY Congress itself emphasizes that scientific progress is becoming an increasingly significant factor in economic and social progress. However, in our self-managed social system the workers in associated labor are supposed to be the principal vehicles of that progress and the beneficiaries of its fruit in creating new opportunities for their own and overall social development.

Putting the question this way implies not only the need for a new science policy based on and governed by the humanity of social relations, but also the need for a new social system based on self-organization and consensus. At the same time, statist structures, even when they are socialist, are not proving themselves to be in essence a qualitatively new solution with respect to facilitating the inroads of modern technology into human life and the management of that technology, and one reason is that they are not creating an opportunity for vigorous massive supervision by the direct producers and other creative subjects, who are at the same time its users. Keeping account of the technical and technological progress of the material base of society's development is for the progressive forces of the contemporary world also a struggle for new and progressive social relations, since the latter cannot develop at a lower technical level, the converse also being true, since present capitalist social relations cannot in the totality of the system gain a mastery of the new productive forces and lead necessarily to crisis and conflict, as the seventies have been demonstrating.

Today the results of the scientific and technical revolution are in great measure being appropriated by the structures of monopoly capital and the statist technocracy. This is a powerful brake on creation of unity between the social and technological components and constitutes the greatest danger to future development. The problems of the scientific and technological

revolution are not merely problems of science and technology, then, but also a revolution of societies and their social makeup on a world scale. More than that: these are the problems of the overall development--and more and more the survival--of our civilization.

Social revolutions and great revolutionary class movements have been preparing the way for the technical revolution, and the latter has been confirming them and creating conditions for the new social revolution. Today processes of this kind are taking place more and more simultaneously. The contemporary scientific and technological revolution is imperatively placing on the agenda the problem of the integration of production relations and social consciousness, which must cross national borders and encompass the entire world. The powerful internationalization of technological--and more and more of social--research is before us. It is objectively opening up an opportunity for socialism's breakthrough into the world.

At the same time, technocratic tendencies and technocracy are developing in the contemporary world as a relatively potent factor because the development of the productive forces and the nature of production processes require today a structured professional management staff with great authority in the work process, and that gives that staff a particular economic and political force and thereby a kind of social independence. But the technocratic monopoly cannot exist in isolation; it can only be the derivative of the capitalist monopoly, of statism based on state ownership, or of distorted self-management in the form of group ownership.

Technocracy has a pragmatic attitude toward science. It sees science as merely a multiplied productive force, a means of strengthening the economic power and ultimately the political and social power of some elite, while the general goals of society it finds negligible by comparison with the needs of technological development. At the same time, that technocracy is frequently criticized without knowledge or professional competence, out of a fear that the dynamic modern structure of society, based on scientific thought, will redistribute the present loci of influence and diminish the opportunities for personal power and manipulation. Passing for a criticism of technocracy, primitivism and cultural and economic underdevelopment strive to prevent the modernization of social organizations, retaining real power on the basis of the myth of the permanent struggle against the dehumanization of the "consumer society."

Industrially advanced bourgeois society, capitalist monopolism and statist socialism resolve the problem of the relationship between science and society by means of the autonomy of science, by taking science out of the general sociopolitical dimensions, and by cultivating science as a separate and socially privileged enclave whose internal life is to one degree or another governed by different rules, rules which depart from the rules which govern the entire society, or they resolve it by exercising rigid financial control and control over research interests.

Overcoming the contradiction between industrial and scientific civilization, which is just coming into being, i.e., the contradiction between the educated elite which have the power of science and technology in their hands, the owners and the holders of power, on the one hand, and on the other the multitude of those who do not have that power and whose destiny depends too much on the former, will be an exceptionally difficult problem throughout our era. This will be an era of conflict of the revolutionary socialist and humanistic forces with technocracy and scientism and with coalitions of these new reactionary tendencies, with the old reactionary circles of bureaucracy, capitalism and world imperialism. Contrary to its capabilities of human liberation, the new technology is being abused by conservative and reactionary forces, it is being used for introduction of more efficient and subtle forms of social control, repression and militarization which are standing in the way of revolutionary policy, especially in the context of aggravated class conflict, and they are stabilizing existing institutions.

Marxist critical theory, which is the means whereby science is again returned to man and his world and in which man and his future become the basic problem of science in the most direct and specific way, is extremely important to overcoming these processes. The leading role of the working class in an advanced self-managed society represents in our specific condition a real social opportunity for the scientific and technical revolution to be put at the service of the historical process of the liberation of humanity. The scientific and technological revolution is a profound social movement, a movement, that is, on the part of all the productive forces of society, and not merely of a particular social elite. The individual parts of society do not in any case play equal roles in this process, but this cannot be a matter for a small group of people, but is the business of the contemporary working class as a whole, which on its own is transforming itself and integrating itself with those who are engaged in intellectual work.

2.3. The Organization of Research and Development on a Self-Management Basis

The socioeconomic position of the workingman in social reproduction is the foundation of socialist relations, and by virtue of his work with socially owned means of reproduction it must afford him--on a direct basis and on an equal footing with the other working people in associated labor--the opportunity to make decisions about all matters concerning social reproduction under conditions and in relations of mutual dependence, responsibility and solidarity. He thus pursues his own personal material and moral interest and exercises the right to enjoy the results of his work and the achievements of general material and social development and to develop his own work skills and other creative abilities.

If we want to realize the idea of associated labor in the area of creative scientific work and the idea of an uninterrupted dialectical intertwining between science as a theory and social practice, then it is of the most essential importance to create equal relations of mutual influence and responsibility between the participants, who are self-managing principals in

scientific activity, and the users of scientific results. At the same time the opportunity should be created for the presence of this science of ours and its results to be felt at all levels where decisions are shaped, from basic organizations of associated labor all the way to associations, to self-managed special-interest communities, and to sociopolitical communities and organizations. It is not merely a question of research activity being permeated by the interests and needs of our working people, but also of the reverse--of the intellectualization and scientization (permeation with science) of those interests by needs and by the life of society as a whole. Certainly this will require some time, but the question of whether that time will be long or short depends on the subjective factor.

3. The Goals of Science Policy and the Priority Lines of Research

3.1. The Goals of Science Policy

Since the war science policy in the advanced European countries has consisted in the building and augmentation of the scientific potential for the new role of science, which in addition to its learning and educational functions, also acquired a productive function. With respect to methodology terms and categories were worked out for measuring research and development within one country and for comparison with other countries.

During the postwar period and especially since the early sixties science policy in Yugoslavia has been oriented primarily toward building up the basic staffs and physical facilities in more or less all fields of science, with a certain advantage given to the natural sciences.

The new conception of the science policy of the advanced countries was formulated after the task we mentioned in the first postwar phase was by and large carried out. Science policy is expected to find ways of fitting and integrating scientific activity into the country's economic and social development. Science is to serve the goals of society. Research and innovation have to be concentrated on solving the problems of society, on strengthening the country's economic potential and on improving the general conditions of life.

The staffs of scientists and scientific institutions built up during this past period in Yugoslavia now represent the basic conditions for scientific activity to become a vigorous factor today in the country's general social and economic development. In our young socialist self-managed society, in which the process of industrial development has not yet been completed, there is a possibility and need for scientific activity to be so oriented that it becomes an effective factor in realizing the technological, economic, social and cultural goals of the country's development and is incorporated as an integral part of the mechanism and dynamics of that development. The further a country goes in its development, the more manifest the importance of science and technology becomes in its development. Our country has historically reached the point where science and technology are becoming decisive to future development, and that is why its policy in science

and technology needs to be defined. Society's science policy then stands on an equal footing with society's policy in the fields of economic affairs, education, health, culture and social welfare.

In this sense science policy is taken to be a set of principles, guidelines and actions which will be taken in the coming period on the basis of consensus. Science policy has its strategic goals, goals which pertain to the entire society by their very nature, and it has long-range goals (10-15 years) with respect to the time dimension. These are not the abstract goals of science, but society's goals of science policy. Tactical and scientifically formulated goals are derived from the strategic goals, and they are elaborated in operational terms for shorter periods of time (1-5 years). As the basis for science policy, this document is concerned with long-range strategic goals, while the short-term tactical goals are subject matter for adoption of specific programs and should not be looked for here. In its setting of goals and selection of the main lines of research this document relies on the document of the Federal Executive Council entitled "Basis of Joint Policy Governing Yugoslavia's Long-Range Development." In large part that document itself was our science's contribution to definition of long-range development policy embodied in the macroproject entitled "Conception of Yugoslavia's Long-Range Development up to 1985."

The "Resolution on Tasks of the LCY in Development of Science," which was adopted at the 10th LCY Congress, states that it is indispensable to formulate a strategy and long-range program for scientific research as part of elaboration of Yugoslavia's joint long-range development policy and that the work already begun on that should be stepped up and brought to conclusion in the republics, autonomous provinces and Federation.

The overall goals of the Bases of Science Policy in Yugoslavia can be put in three groups:

i. technological and economic,

ii. social and humanistic,

iii. general cultural goals.

The priority lines of research will be derived from those goals.

These goals make up a system in which they qualify and complement one another. The best conditions for achievement of each goal separately will be created by harmonious achievement of all the goals. The group of technological and economic goals is aimed toward providing and developing society's material base. The group of social and humanistic goals is aimed at building and developing the social system and the organization of life and at building and developing their defense and protection. The principal significance of the group of cultural goals in this context follows therefrom. Progress, growth in depth, authentic growth is viewed here primarily as

growth and progress attained through knowledge. Society should acquire the ability to assimilate and use knowledge. In historical terms technological and economic goals, which are oriented toward development of the physical sphere, are more important in a less developed society. In an advanced society goals oriented toward appropriate organization of society become dominant; in Yugoslavia they are oriented toward self-management organization to safeguard the higher interests of society and the individual and to create the appropriate framework for the functioning of the advanced economic base. In Yugoslavia this historical pattern is manifested in the operation of two groups of goals nuanced as a function of the higher or lower level of development of the various republics and provinces. Yet both goals are based on the historically quite recent ability of mental labor to be the point of origin of their fulfillment.

The third group of general cultural goals is a more narrow and specific area. The general cultural goals encompass the development of science itself and of research and development as a separate subsystem, but they also affect the adjacent subsystems of education and general culture. This group figures as a prerequisite for attainment of the technological-and-economic and the social-and-humanistic goals, which is why it must also develop on its own, so that it is an ever stronger driving force for progress. Science and education are the germ of growth which should today act as a catalyst in every human activity. In its relation to the first two groups, then, the third group figures as a means of their development, but in and of itself it is also a goal of society and of its science policy.

All three groups of goals can be unified in the synthetic goal of linking world scientific and technical progress with the development of a socialist self-managed society in our country; and, more than a linkage, that world progress must be incorporated and absorbed into our original social environment and organization according to its own laws of development, not those from elsewhere. In that respect a self-managed society offers unprecedented advantages and opportunities, but it also embodies its own specific contradictions which have to be overcome.

The borrowing and development of new technology must not result in the deformations typical of the consumer society or in a statist neglect and subjugation of man as a person. We will have to avoid or at least diminish the well-known ailments brought by technical civilization, which make of man an alienated and neurotic being in the midst of an abundance of goods. In capitalist society things are produced for consumption as an end in itself, and not in order to satisfy needs. Artificial needs are created, and resources are squandered extravagantly so as to avoid the crisis of capital and capitalist relations. In essence capital is manipulating science and man. To a great extent science is in bondage to the wage relation and is fulfilling the needs of an economy with that kind of bias, an economy whose goal is primarily the reproduction of capital. In our socialist society science should contribute to the formation of a different model of production and of the economy.

3.1.1. Technological and Economic Goals

The technological goals--and in a broader context the economic goals--are aimed at introduction of new technology into the economy. This is today's challenge to Yugoslav science in a relatively new area where a broad inroad has still not been made, but the R&D potential already created is available for greater commitment. New technology, in the sense of a new or improved production method, accompanied by new materials and up-to-date technical equipment of industry and other crucial sectors, tends to raise labor productivity, reduce production costs, boost competitiveness on the international market, and strengthen the country's defense capability. This is at the same time an area in which our R&D can yield sizable benefits both with its own solutions or through a creative transfer of foreign solutions.

In contemporary society deliberate development of basic, applied and developmental research creates an opportunity for introduction of technological innovations into the economy, industry above all, and processes are shaped which encompass and integrate research, development and production. The task that arises is to conceive and initiate research and development aimed at innovating production technology along the main lines of the country's long-range development. This research should be part of the long-range research program up to 1985, and even beyond that, and as an integral component in Yugoslavia's joint long-range development policy, it should be among the long-range plans of the Federation, republics and provinces. Realization of the program of that research is guaranteed by planning discipline. This is at the same time the way of preventing science policy from remaining a declaration without great practical significance or benefit. However, the vital heart of these major research and development programs will be in the economy itself, in the action of associated labor, adopting self-management accords within the framework of large integrated interrepublic and Yugoslav economic complexes and technical-and-economic systems, to shape such research undertakings and to provide most of the financing. The "Basis of Joint Policy Governing Yugoslavia's Long-Range Development up to 1985" provides for the shaping of those integrated complexes.

It has been calculated that a long period of time lasting as much as 10 years is required for the cycle of an innovative process from theory to application, from laboratory research to the final phase in which prototypes and pilot plants are set up, all the way to commencement of industrial production (the "zero theories"). At the same time, the process of research and development itself requires quite a long period to mature and to yield solid results. This is therefore long-range research, and for several reasons it is the most difficult to conduct and to bring all the way to a physical product via experimental development. In cases when the cycle is not complete, but the intention is to make partial changes so as to improve a production procedure, which in our practice will be the most frequent case, research and development will be somewhat shorter, and application speedier, but it will still have its place in long-range programs. The reference is to major undertaking at important points: for example, the undertaking in

metallurgical technology to reduce coke consumption. Long-range research is conducted by phases, and the results of the various phases may also be suitable for application.

The infusion of new technology is a very complex and delicate process, particularly in a smaller country still in the development stage like Yugoslavia. New technology can in principle be created in two ways: by applying one's own innovations to technology and by borrowing foreign technology. The question immediately arises of a general orientation between these two possibilities and also of a third which would combine the two. Then the question arises of what kind of borrowing of technology should be done? This is followed by the question of a general transfer of knowledge from science to the economy. Generally speaking, the answer is that the creation of one's own technology, a technology capable of establishing itself on the international market, is possible in a relatively narrow area. But the borrowing of foreign technology must not be mechanical and unorganized, but must be creative and selective; our own research and development potential must also make itself felt here. The orientation toward our own resources is our basic strategic commitment.

So far the country's industrialization has been based primarily on the borrowing of foreign technology, on the importation of foreign licenses and foreign know-how. In the initial phase of industrialization, when emphasis was on extensive development, this orientation in the policy governing technological progress was understandable and necessary. However, the new phase of industrialization, which will be oriented toward modernization of the industrial structure, toward intensification of production, and toward higher product quality, necessitates a stronger orientation toward our own knowledge as a source of technical and technological advance. Modernization of the industrial structure will signify development of an industry with a high coefficient of research and technology, above all the chemical industry, the pharmaceutical industry, the electrical equipment industry, metal manufacturing, and the food processing industry. This kind of development cannot rely exclusively on a mechanical borrowing of foreign technology for several reasons: a) the foreign technology will be applied to our own technical-and-economic conditions, which necessitates an adaptation of the imported knowledge, i.e, some original research; b) the technological development of these industries is very rapid, which necessitates an effort toward ongoing improvement of the imported technologies, which also signifies an effort in development of our own research; c) the effective and rapid transfer of foreign technology cannot be done at all unless one has scientific knowledge of one's own and one's own research facilities; d) horizontal transfer of technology from one country to another takes place under much more favorable conditions through exchange than purchase. The experiences of the advanced countries show that only a country whose industry is producing its own innovations in its own laboratories can be in a position to obtain the best and most up-to-date licenses and have access to the most advanced knowledge outside its borders.

It is well known that the licenses which our enterprises are purchasing represent with minor exceptions knowledge that is more or less outdated, and that keeps our economy in a subordinate position relative to the advanced countries. A disconnected and unselective approach results in the importation of differing technologies in one and the same field, which makes it harder to create integrated technological systems. It also happens that a foreign partner will make his investment credit conditional upon the purchase upon a particular license which is usually unfavorable. The purchase of a foreign license signifies the purchase of an end product of research and does not signify attainment of that invisible and intangible part of research that is embodied in the license--research acumen and theoretical knowledge. Excessive reliance on the borrowing of foreign technology would lead, then, to a stunting of the creative potential of our own science and technology, and that would have a feedback effect on the economy, ultimately perpetuating our economic lag. This is shown by figures on patents and invention in our country, which is lagging considerably behind the advanced countries. Significant results in the development and establishment of domestic technology have so far been achieved, according to statistical data on the number of patents, by the pharmaceutical industry and then by agriculture and to some extent the metal manufacturing industry. A quality breed suitable for export has been created with the help of our institutes in meat production. With the help of institutes and units, it is true, numerous technical improvements have been adopted in our economy though they do not represent patents and are not subject to registration, and this does improve considerably a picture that otherwise is unfavorable.

In the light of all this the orientation of the Yugoslav economy, and especially industry, toward development of our own knowledge as a source of technical and technological advance imposes itself as an objective need. This orientation should be achieved gradually, through the creative and selective transfer of foreign technology, through so-called adaptive and imitative research, both of them taking place in cooperation between domestic enterprises and between the latter and foreign enterprises. This is the road taken by some countries which are very advanced today, Japan for example, and it proved to be very effective. The point is that it is not only necessary to purchase the entire technology of a process. The exporter of the license tries to sell the entire package. The importer, however, may purchase only certain parts of the technology and provide the other parts through domestic research and development facilities. He must, of course, have good information about domestic capabilities, which should also be a concern. This kind of partial transfer of technology and partial purchase of a license, combined with the application of domestic know-how, may at the beginning be slightly more expensive, but it pays off in the long run and is conducive to the healthy development of technology and production in our own country. In other words, foreign know-how may be imported in such a way as to stimulate the development of our own research and research centers, rather than deadening them, as has frequently been the case in the past. Our research and development should keep up with the trends in development of world technology and should make itself capable of reproducing that technology under our conditions.

At the same time, the creative approach to obtaining our own technological solutions and licenses is possible and necessary in narrow and well-selected areas where we can offer an original contribution at the top level and sell it as a license in division of labor with other countries. To be specific, we should endeavor to do this in the principal sectors in the country's development and in industries which are science-intensive. With respect to technological processes already adopted, our research and development may achieve certain improvements and adaptations for application in our own production and also for export. Selectivity in the choosing of foreign licenses means analyzing the possibility and optimality of its application and of its further development in our community before a license is purchased. Those advance analyses should in future be conducted by our competent scientists and specialists at the economy's expense. Compiling the country's technological balance, including qualitative and financial indicators concerning import and export of technology would be very useful to pinpointing our orientation in this complicated problem area.

According to the data of the Yugoslav Economic Chamber, up to the end of 1972 500 contracts have been concluded for the purchase of patents, licenses, know-how and manufacturing instructions from abroad, and 76 contracts have been concluded to sell Yugoslav technology abroad (1960-1970). The value of the foreign equipment imported was $10.3 billion in 1971, while the value of equipment produced in the country ranged at approximately the same level. Foreign technology is also imported along with foreign equipment.

It is also worth emphasizing that the fulfillment of long-range programs for introduction of up-to-date technology, up-to-date organization of work and other components of development goes far beyond the sphere of scientific activity proper. This must be primarily in the hands of the economy itself and of associated labor. Today, even according to foreign judgments, the economy already possesses a relatively sizable research and development potential in the form of institutes, centers and units.

A long-range policy governing the transfer of new technology and new knowledge needs to be introduced. It must not be limited to a policy governing the borrowing of foreign technology, but should also embrace criteria and methods concerning dissemination of technology in Yugoslavia as well as transfer to other countries. In our practice to date the lack of a unified policy governing the import of foreign technology has been felt strongly:
a) Imported technology has not yielded the expected benefits in terms of the rise of the overall rate of the social productivity of labor, nor in terms of raising the efficiency coefficient of fixed capital (fixed assets);
b) Uncoordinated investment policy and fragmented, duplicated and unutilized production facilities have stood in the way of effective application of new technology and development as a whole; c) The importation of foreign technology has been guided above all by commercial considerations, and there has been a neglect of advance study of the expected production results and of the forecasting of probable technological changes; d) No mechanism has been

set up for stimulating efficiency expertise and innovation; e) To a considerable extent problems related to dissemination of technology within Yugoslavia and also to retransfer or the export of our own technology to other countries, especially to the developing countries have been neglected.

It would be worthwhile if associated labor in the economy were to set up a separate self-managed body which would conduct the policy governing the import of foreign technology and also the policy governing the transfer of technology in general.

What is referred to as the technology of management, as distinguished from the technology of production, is a separate domain in the transfer of technology. There are modern and scientifically grounded methods of management and organization which are not only being introduced at the enterprise level, but embrace the entire economy and social services. Modern technology does not come without modern organization. The organization of work, advance and current planning, the management of finance, production, personnel, transport, the R&D service--all of this is equally important to the efficiency and optimality of business operation. In a sense it is Problem No 1 of the Yugoslav economy. Up-to-date methods of management and organization are usually introduced by consulting firms, and this has developed into a special type of activity called "consulting." In engaging the services of foreign consulting firms one should take care that the foreign organizational and technical solutions are adapted to our social relations and are conducive to development of self-management relations in production and in work.

However, in the coming period priority cannot be given exclusively to certain sectors of industry whose rapid development is made possible by scientific-technical progress and which have a propulsive effect on the entire economy. Production of energy, raw materials and food constitute the natural and technical platform for the further development of industry itself and is today the decisive factor in economic activity and development not only in Yugoslavia, but throughout the world. Our economy feels the retarded development of the fuel and power industry and of the basic raw materials industry. The development of agricultural production and of the agricultural food processing complex, though significant, shows fluctuations in production and a lag behind domestic needs, and it is causing economic instability. Dependence on foreign countries is excessively great in the fields of energy, raw materials and food, bringing the well-known adverse consequences for the country's balance of payments.

For all these reasons the technological and economic goals of science policy should be primarily oriented toward adoption of long-range R&D programs in the fields of energy, raw materials and food. Utilization of natural resources, preparation of raw materials for industrial use, and biotechnical measures in agriculture have their own sizable R&D component, which will make itself felt in the priority directions.

In conclusion we should repeat that the technological and economic goals of science policy are focused mainly around the process of the country's industrialization in the coming period, including the production of energy, raw materials and food. According to the basic indicators, our country has reached approximately halfway in its industrialization by comparison with the advanced countries. Industrial development in turn has had and will continue to have a propulsive effect on society's entire base and superstructure, at the same time incorporating its methods in nonindustrial activities as well. However, the process of industrial development is no longer based so much on construction of new production facilities; rather, a larger portion of the growth of the social product comes from the advancement of production within the domain of technology (as much as 87 percent according to foreign analyses). Under the impact of the factors of scientific-technical progress we expect a considerable rise in the growth rate of the efficiency of fixed capital in the economy, as well as a general rise in the rate of the social productivity of labor. An analytical projection is shown that under favorable conditions the impact of science and technology in the period up to 1985 would be an overall annual growth rate of labor productivity 2 percentage points higher than the rate achieved in the 1960-1970 period, which represents a tremendous benefit.

3.1.2. Social and Humanistic Goals

As we have mentioned, the tendency in the group of social and humanistic goals is toward development of the social system and the organization of life. The relation of this group of goals toward the group of technological and economic goals has been sketched. The development of the social system for us means primarily the development of the socialist system of self-management. Self-management is a specific sociocultural system differing from all other systems in the present and past. As it creates its own values and standards of measurement, that social organism must actively incorporate science into itself so as to achieve its own scientific definition and to foresee the course and development of its human values. This is an encounter with the unknown and a step into the future, and it is scientific subject matter and a scientific concern par excellence. In the sphere of the social superstructure science figures as a factor for establishing certain real elements of the present and for forecasting optimum solutions in the future. Science here comes into contact with ideology, which cannot be altogether replaced. By relying on ideology and without falling into scientism, functionalism or positivism, science can provide analyses which will portray an objective picture of society, reveal its internal contradictions and offer a choice of possible directions for action or development. The social sciences can gradually undertake to elaborate an entire theory of self-management as a social system on the basis of Marxist theory.

In the world today people are realizing that a fetish should not be made of material development, that the economic indicators of development do not offer a full and realistic picture of life, which is based on human values. It can be said that the world expects certain experiences and results from

our self-management in terms of affirming those human values, even if a certain price is to be paid for them at the expense of economic efficiency. These are values such as enjoyment of life, self-fulfillment of a person liberated from oppression and exploitation, the master of his destiny, of his work and of the surplus value of his work, a person who is free but has a sense of responsibility and solidarity, a person with a right to make social decisions, a person who exists in a wholesome social environment and in an organized living space in the midst of a higher community. All of this represents an outstanding area in which our science can make its own original contribution to world science; to some extent it is already doing that.

In every society which is rapidly developing the social structure becomes highly differentiated, and this in turn creates complex social problems. The social structure undergoes constant changes originating in the economic and technical sphere. The high differentiation of the social structure and the rapid pace of social change constitute deep sources of conflicts which even a self-managed society cannot avoid. Elements of the new and old live side by side at the transition from the capitalist to the socialist system, from an agrarian to an industrial society. Industrialization creates urbanization, which is accompanied by a migration of population. Old human communities are destroyed, traditional human values undergo change. Very little is known about the economic, psychosocial and cultural significance of these processes, whose relevance will not cease with the present day, but will continue into the remote future. This complex of phenomena necessitates interrelated research in philosophy, the sciences of political economy, geography, sociology and psychology, as well as in the relevant disciplines of the natural sciences in order to furnish a scientific underpinning for the community's active socioeconomic policy. That scientific underpinning should provide the possibility of practical action in our organization of society in conformity with the self-management model.

This group of goals encompasses research which will find essential solution for the development of health care and social welfare of the working people and for improvement of working conditions. In this context there is an especial need to intensify research in the medical sciences so that the health standards of the advanced countries are met in the people's health protection and medical treatment and so as to increase the output of the work force. This group also embraces medical treatment of man under wartime conditions.

Environmental protection and the relevant ecological research enjoy priority treatment in the world today as a reaction to the widespread phenomenon of pollution of the natural environment, which is a consequence of contemporary industrialization, motorization and chemicalization. Those harmful consequences, which are not yet so great as in the advanced countries, cannot only be corrected in our country, but in large part avoided. In the recent past a special environmental impact study has been prepared for some new investment undertakings. This is all the more necessary because provision is being made for rapid development of precisely those industries which might pollute the environment considerably.

The other social and humanistic goals are directed toward giving a harmonious shape to man's living space as one of the essential factors in the quality of life. This would include research and models in the fields of spatial planning, urban planning, population and housing studies, diet, transportation, and municipal services.

The component of nationwide defense and state security should be incorporated into this research in a manner suitable to the subject matter being studied. Aside from military research itself, the strengthening of the people's defensive capability and the country's security and the development of the conception and practice of nationwide defense have their place throughout the field of research and development. It is very important to do research on war and defense as social phenomena, on the factors which determine them, and on their impact on other domains of life and work; and then to study the measures and actions which deepen the objective contradiction of aggressive plans from outside and of the actual aggression itself, which energize the objective advantages of the country's defense and protection and fundamental social achievements and prospects, and which strength socialist and patriotic defensive consciousness.

3.1.3. General Cultural Aims

The group of general cultural aims is a more narrow and specific area in the bases of science policy. The general cultural aims embrace the following:

a) Development of science and of organized research and development as a relatively autonomous subsystem of society;

b) The impact on the educational subsystem and interaction with it;

c) The impact on general culture and level of civilization in the country.

Their common aim is for new knowledge to be incorporated into all social processes, for society to master the ability of assimilating and using knowledge.

A) The measures of science policy will ensure the maintenance and augmentation of scientific capabilities as a whole over the coming period. There is a need for consolidation and more optimum organization of scientific activity as one of the important social services. A rapid increase is envisaged in the number of scientists, which should almost double by 1985, and then the productivity of scientific work should increase, particularly thanks to larger purchases of equipment for institutes, an area in which we lag far behind. It will still be necessary to make sizable investments to build new facilities and to develop the infrastructure for scientific activity. The number of institutes and units is relatively great--over 400, so that the emphasis will not be on establishing new institutes, but on consolidation and on programmatic coordination and spatial unification of existing facilities. Many of them are operating below the critical threshold of effort

because of their small size, but were they coordinated in carrying out large long-range programs and jobs involved in direct exchange of labor, they could achieve higher efficiency and exert a stronger impact on practice. Both will be tasks of associated labor to be performed through self-managed special-interest communities and of the scientific organizations themselves, and the agencies of the public community have an important role in working out elements of the system to favor scientific activity and in general to guide that activity according to social plans.

At the same time the cultural goals are bent toward development of scientific thought as a source of new knowledge about the world and as a means of deepening and broadening the fund of knowledge. This refers to basic and theoretical research oriented toward a general growth of knowledge in a given area. Basic research is a source of new knowledge and the theoretical basis for all applied research. As we have said, a country which has no pure chemistry will also lack applied chemistry as a technology, and so on. The setting of this goal amounts to issuing public credentials to basic research, but no longer as an abstract and vague category, but as one of the recognized and defined goals of the adopted science policy. This needs to be emphasized because those who commission research sometimes display a pragmatic and practicalistic attitude toward scientific activity, failing to see that activity as an organic whole. On the other hand, it means that in the development of basic research in both the natural and social sciences consideration will be given to the other goals of the established science policy, which interact with one another and complement one another. As a rule basic research will have a direct relation to applied research, and beyond the latter will be indirectly related to developmental research in the economy, with the activity of the university in the educational function, and so on. Advantage today is given to what is called goal-oriented research, which means that narrow fields where there is a possible application are studied at the theoretical and laboratory level, consideration being given to the country's advantages in terms of natural resources and development capabilities. However, within a certain radius basic research remains free of the other goals and stands as the overall basis of knowledge and application, as the pathway for transfer of results and methods from world science, which is especially important to our country. The opinion prevails in the world that it is good to leave a certain area open for free research, research referred to as exploratory research, in established institutes; this kind of research requires smaller funds, and it maintains the creativity and freshness of the researchers. As we have said, space must be left "in one corner of the laboratory" for this free work.

B) An impact will be exerted on the subsystem or sphere of education at several levels, and the educational sector will in turn have a feedback effect on science. First of all, scientific activity directly raises the professional and educational level of postsecondary teaching. The educational role of science at the university is a traditional one, and indeed science itself came into being there. For a time our universities were purely teaching institutions, which has proven to be a mistake. The reform of

higher education now taking place is aimed at reorganizing the universities and their constituent schools as combined teaching and research institutions. Science policy will aid all those developments leading toward full participation of institutes of universities and their constituent schools in postsecondary teaching and will favor establishment of scientific centers for complexes of related disciplines and fields which combine teaching and research. These centers ought to replace the present institutes, which often are tiny and detached from their parent university community. In addition, even the so-called independent institutes will become involved in teaching at the postgraduate and senior postsecondary level since their personnel and laboratories will be involved, something which is being done to some extent even now, for example, in the nuclear institutes and elsewhere. By the nature of things basic and theoretical research will always be carried on in the universities, but this will vary from one republic or province to another in view of the differences that exist in level of development and orientation. In schools of engineering and similar fields important applied research is being done under contract with the economy, frequently in cooperation with R&D institutes and units in industry, agriculture, transportation and elsewhere. In the less developed regions frequently university schools and other senior postsecondary schools are even today the only possessors of theoretical and highly specialized knowledge, and professional organizations and services rely on them and their research.

There is a need for a further substantial increase in the mobility of specialists in the triangle consisting of the research institute, the university school and the economic organization; this mobility is very low in Yugoslavia compared to the advanced countries. The only flow of any strength is from the institutes and professional organizations to the university schools, which in a way is a reflection of an underdeveloped community. Higher personnel mobility breaks up closed and sometimes mummified structures and essentially facilitates the circulation of ideas and the two-way transfer of knowledge between theory and practice. These relations must exist in society if science is to cease to be an area closed off to all but a few and become one of the active factors in overall social development.

The resolution of the 10th LCY Congress we have quoted from states that a distinguished place in long-range programs must be given to the study of the system of education and upbringing at all educational levels so that it is brought into conformity with the present needs of the economy and of society as a whole and so that scientific achievements are incorporated into the contents of the teaching and educational process. The present system of education and upbringing is burdened with many traditional views, and education is adapting slowly to changes in the work process. The volume and pattern of the social fund of knowledge will be undergoing continuous change under the impact of scientific and technological progress and the development of physical production and the social services. There will be an increase in the share of so-called complex fields of knowledge. That is why the physiognomy of personnel must adapt to the needs of long-range material and social development. In industrial production the worker's role is making a gradual transition from physical labor to the monitoring of production

and the control of instruments. A greater role will be played by R&D, which include research and development projects, the manufacture of prototypes and the setup of pilot plants. A sector of new industry will develop and will make ever greater inroads into the sector of tertiary activities, and so on. The total number of educated personnel will increase from about 55 percent of the work force in 1970 to about 72 percent in 1985. All of these new phenomena indicated in the "Basis ..." we have quoted from, in addition to the inherited gap between formal education and actual practice, will necessitate scientific study and treatment in the pedagogical, economic, sociological and other sciences. Pedagogy is one of the least developed disciplines in the social sciences with respect to its organization and the material basis of scientific work. Certainly a larger scale of research would have a beneficial effect toward improvement of that situation.

C) The impact on the general culture and level of civilization in the country represents an intermediate goal, one which is so diffuse and almost invisible in nature that it could escape attention and might create inexplicable difficulties at first glance. First of all, the application of the results of science in practice necessitates a steady growth in the general and specialized education of the broadest ranks of the producers and the gainfully employed population. This begins with the educated producer who is a skilled workman and who has not only solid specialized knowledge, but also certain standards of workmanship, and it goes all the way to mastery of the scientific way of thinking by our average man. The goal is for science to become the basis of all activity in our society. This goal is alien to a man with a mythological way of thinking. The lower the level of general civilization in a country or one region of a country, the lower that community's capacity to absorb the achievements of science. This is an objective circumstance which cannot be overcome by any sort of isolated subjective effort. Scientific activity participates in the general boosting of the cultural level by building up the national culture (humanistic science) and through its concern for popularizing scientific achievements, particularly with young people, which should in future be given more attention for the reasons given. The creation of demand for science is possible only in an environment capable of grasping the dimensions and capabilities of contemporary science, in an environment with a certain level of cultural development. In other words, the development of general culture, of susceptibility to scientific ideas and to new scientific-technical solutions, particularly in the circles responsible for application of science, also represents one of the essential conditions for establishing the social functionality of science.

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[Text] 3.2. Priority Lines of Research

The programming of scientific work at the national level is beginning today with the setting of the goals of science policy and with the selection of priority lines of research in conformity with the principal tasks in the country's socioeconomic development.

The selection of research priorities generally depends on the country's size, general makeup, social system, natural resources, national culture and scientific potential. Internal and external criteria governing selection of priorities are usually given in the literature. The internal criteria are manifested in narrowly specialized scientific arguments, in capabilities and inclinations within scientific activity to engage in scientific research and to solve a particular set of problems. These include the following:

a) the level of development of the particular discipline or field by an international and domestic standard of measurement,

b) the quality and quantity of personnel,

c) the equipment of institutes and cooperators,

d) results achieved in the relevant sphere of research,

e) available information and documentation,

f) the possibility that renowned participants within the country and abroad might become involved.

The following are specific signposts in this respect:

a) long-standing tradition in study and research,

b) recognized results at the international level,

c) personnel of outstanding caliber, scientists who are important figures in the relevant discipline.

Experts themselves familiar with their own field of research and actual research capability in that field provide the answers to the questions concerning internal criteria.

The external criteria are expressed in the objective values which will be discovered, embodied and enriched by research--natural, economic, social, cultural and other values. The external criteria start with the country's existing advantages and aim at their utilization or development. They may be the following:

a) geographic position (for example, maritime, transit, and so on),

b) natural resources (ores, raw materials, soil, water, forest),

c) population and manpower,

d) productive capabilities,

e) export capabilities.

The external criteria then extend to the following:

a) government and social system (for example, the federal system, the goals a society is pursuing in its construction),

b) moral values,

c) historical values,

d) cultural values.

One of the principal indicators pertaining to the external criteria to be used in a long-range program of joint research at the level of the entire country will be general documents on the country's long-term development and the social plan for Yugoslavia's development. A specific indicator for selection of research will then be those areas which are suitable for development through research, those where technology is improving rapidly, in the science-intensive industries which science has, so to speak, created or has greatly stimulated development: for example, the electrical equipment and electronics industries. Science has less it can do in industries where technology is more stagnant.

The financial factor also has to be taken up in studying priorities. Priorities serve the practical purpose of orienting the agency funding the research in deciding where to invest funds. Since nowhere are funds so abundant that everything can be financed, some choice in commitment must always be made. The funds on the other hand must be sufficient so that the priorities can be financed without detriment to the balanced development of research and development as a whole within a country's given limits. The priority fields of science undergo intensive development, while the other fields of science experience normal development. The first limiting factor in selection of priorities is the more or less limited scientific potential, in particular scientific potential in terms of personnel. Research should not be undertaken unless the so-called critical threshold of effort can be achieved in terms of the number and quality of researchers and with respect to resources, since this is indispensable to success. It is not so uncommon for this to be done. Getting back to financial capabilities, they can be a second limiting factor. Here it is assumed that total resources available for research and development have reached the critical mass allowing for freer and more far-reaching undertakings. Funds are concentrated on the priorities which have been selected, but the normal existence and activity of the existing scientific structure must not be neglected. According to foreign assessments, the transition to a modern science policy with differentiated goals and established priority becomes possible at a rate of allocation of 1 percent of the national income, and it is inevitable when the rate of allocation for research and development reaches 2 percent of the national income. In Yugoslavia the overall rate of allocation to science is now estimated at slightly higher than 1 percent, and a rate of 2.4 percent is projected up to 1985. This means that at first the funds may figure as a

rather strong limiting factor. However, the resources at present certainly include potential that goes unused because of irrationality and inefficiency. At the same time, the long-range strategic research and development projects we are referring to here would have to be given certain funds pooled on the basis of self-management, especially for the development component, which would be the most expensive. Sound results will not be forthcoming unless this takes place.

From the methodological standpoint the priority and basic lines of long-range research are formulated as large tasks of society (economic, social and cultural), and not as a narrowly professional set of topics and subtopics for study. The individual projects and topics with clearly defined tactical goals of research are formulated in scientific language in the second phase of preparation.

The long-range strategic research at the Yugoslav level--federal and inter-republic--will be carried out on the basis of complex cooperation involving a sizable number of partners from various sectors (which is nothing specific to our country). Coordination will therefore be needed through a coordinating agency: both at the microlevel of the institute and at the macrolevel of the higher agencies. Without this effective coordination these complex undertakings, even though all other conditions obtain, may still prove fruitless. Coordination on the other hand must not be merely formal and administrative, nor bureaucratic.

In selection of the priority lines of research this document takes as its point of departure the goals that have been established for science policy, and it relies on the following public documents: "Basis of Joint Policy Governing Yugoslavia's Long-Range Development up to 1985" and "Social Plan for Yugoslavia's Development in the Period 1976-1980." Moreover, use has been made of the principal results of the research done as part of the macroproject entitled "Conception of Yugoslavia's Long-Range Development," summary study published by a consortium of economic institutes in Belgrade in 1974.

3.2.1. Survey of the Priority Lines of Research

Priority Lines of Research Arising Out of the Technological and Economic Goals

The principal orientation in production envisaged in the "Basis ..." referred to lies in a new phase of the process of industrialization. Industry's share in the gross social product should be about 45 percent toward the end of the period, so that the economic structure would take on the features of industrial development. The priority lines of research will be aimed toward production of energy, raw materials and food, toward certain sectors of the chemical industry, the electronics industry and the metal manufacturing industry, and then toward transportation and telecommunications.

The orientation toward exploitation and development of domestic resources in the production of energy, raw materials and food has far-reaching and manifold importance to more reliable and balanced development of industry and of the entire economy, to economic stability and to reduction of dependency on other countries.

Within that broad framework technical and technological progress itself should bring about a higher level of mechanization, automation, electrification and chemicalization of production processes, more rapid assimilation of new technology and new products, and up-to-date organization and management of production. With regard to research and development, three priority industries have the front-running role in achievement of that technological maturity. As we have mentioned, these are the chemical industry, the electronics industry and the metal manufacturing industry. The metal manufacturing, chemical and electronics industries have become the strongest industries with respect to their share in the social product, they tend by nature to be propulsive, and they make the greatest contribution to development and improvement of economic activity. They already possess sizable research facilities within their own makeup. Here reality confirms the analyses which have been made, but their development to date is still far from the real needs of an advanced country. The trend of industrial development in the world at large also shows that these industries are continuing to experience powerful development.

It is extremely important to science policy that commitment be given individually to those economic sectors which depend most on research and which are science-intensive. This level of dependence is an objective factor. By contrast with these three industries, the impact of scientific research is quite a bit lower in the light manufacturing industry, though even there it certainly exists. Within that group the food processing industry, which is bound up with the development of agriculture, will have the greatest importance.

We can conclude in general that research and development to fulfill the technological and economic goals of science policy must be concentrated in the coming period on general priorities in the fields of energy, raw materials and food, as well as on engineering and technology in three priority areas--the chemical industry, the electronics industry and the metal manufacturing industry, along with certain other related industry, and also to some extent on transportation and communications and construction in the tertiary sector.

In line with the discussions of priorities, clearly these priorities will not by any means downgrade research and development in other economic and technical areas; it is simply that it cannot be so intensive as in the priority fields. Moreover, all three groups of goals of science policy are complementary to one another, so that science must develop along the entire front to achieve the expected results from priority research.

In these priority fields long-range research programs should be drawn up, especially on the basis of large self-managed economic integrations according to the functional principle, along with differentiated participation of self-managed special-interest communities for scientific work.

1. Research in the Field of Fuel and Power

A joint long-range development program needs to be drafted in the fuel and power industry. On the one hand we know about the difficulties in the world fuel and power industry, and on the other our country's need for energy is expected to triple by about 1985. The development program should include ways of taking advantage of the large reserves of coal, even though most of this is low-calorie lignite. There is a shortage of coal for production of coke, and the known reserves of petroleum and natural gas are relatively modest. Electric power consumption is doubling every 5-7 years. The joint development program should guarantee the necessary production through exploitation of large lignite deposits or thermal plants and through further exploitation of the sizable hydroelectric potential, particularly combined with gradual construction of multipurpose hydrosystems. Nuclear power plants should be included among sources of electric power toward the end of the period. Inadequate sources of petroleum, along with the need to speed up exploration in Yugoslavia as much as possible, impose an orientation toward lasting importation of ever greater amounts of crude petroleum. This is bound up with the laying of petroleum pipelines and the orientation of the refineries toward production of derivatives to support motorization. The natural gas should be used to carry out gasification of thermal processes in industry and of large cities, and gas should go into use as an industrial raw material.

The general association covering the entire fuel and power industry would also be concerned about scientific research and the coordination of development. In all energy fields there is a need for self-managed technical and technological systems to grow up in a framework of mutual coordination. The fuel and power industry is a vital center of the country's entire economic development.

The emphasis in research should be on the questions of the economics of utilizing the energy potential, reduction of transmission costs and discovery of solutions for optimum energy consumption. Independent programs would be adopted for energy raw materials, for electric power, for nuclear energy, for petroleum and gas, for coordination of all systems and for preparation of general studies (for example, a study of the energy balance, which is now being worked on to some extent).

2. Research in the Field of Raw Materials

Our country is oriented toward greater use of domestic raw materials, since imports from abroad are a heavy burden on the balance of trade, while at the same time prices are rising steadily. The shortage of raw materials makes

it necessary to exploit sources of mineral raw materials more extensively and intensively. The main goal pursued here is to ensure the production of the principal metals (iron, aluminum, copper, lead and zinc) and heavy chemical raw materials. The shortage of raw materials in the production of iron and steel, which is supposed to meet the needs of advanced metal manufacturing, can almost be eliminated through more intensive exploitation of iron ore. It has been calculated that domestic production can meet about 80 percent of needs even if steel consumption more than doubles up to 1985. Iron and steelmaking should rely primarily on domestic raw materials and on improved technology to reduce coke consumption.

Our country possesses the largest and most valuable bauxite reserves in Europe. They are the basis for development of an aluminum industry with a large export capability. The production of copper, lead and zinc, which is already advanced, requires further expansion of mining facilities so that the underutilized metallurgical capacities would be employed fully.

R&D facilities are already strong in the production of raw material and the principal metals, especially at the large steel mills. The centers of joint long-range research might be in the economy, in the general industrywide associations, while scientific facilities might be engaged in the natural scientific, technical and economic disciplines. The first joint task would be to complete work on preparation of the Geological Map of Yugoslavia.

In the field of mineral raw materials intensive development of resource exploitation requires exploration in order to increase reserves and research to make exploitation more extensive and to provide fuller utilization of valuable ingredients and more optimum use of the product. Research is also needed to develop the domestic production of chemical raw materials as well as in the field of nonmetallic minerals.

3. Research in the Food Sector

As we have mentioned, food production represents one of the priority economic sectors, the one we call the agroindustrial complex. The goals of long-range development for agriculture itself consist of supporting improvement of the national diet and furnishing sufficient raw materials for the food processing and other industries. In addition, certain reserves of food and livestock feed and surpluses for export should be created. The growth rate of agricultural production will have to be at least 3.5 percent. The principal farm products (wheat, corn) and livestock raising, which has an export tradition, have the greatest importance here. It is also important to the future development of livestock raising that the hilly and mountain region, which represents a major portion of our country's area, be studied and developed.

Strengthening the socialist sector of agriculture, especially in the plains, is in the common interest of all the republics and provinces, particularly with respect to the production of wheat, industrial crops and fruit, as well

as livestock raising. In the production of wheat there are objective possibilities of creating surpluses for export, and corn is an important export item. In the private sector cooperation is to be further strengthened with the socialist sector in the food processing industry on the basis of the new self-management relations. Cooperation can pave the way for faster penetration of up-to-date knowledge, equipment and technology into the farming of the private sector even without large capital investments.

A solid foundation for agricultural and biotechnical research exists already in existing scientific organizations and also in the large agroindustrial combines. Certain top-level results have been achieved in the biotechnical sciences, results which can serve as a model of the combination of borrowing foreign knowledge with its creative application to domestic needs. The successful research of our geneticists has found application in creation of hybrid varieties of grains suitable for our soil and climatic conditions. Institutes in the biotechnical sciences throughout the country are well along in establishing interrepublic links and in coordinating their research, and they have also developed international scientific cooperation. Their integration within republics and provinces is a greater problem, one on which work is also being done.

The social compact recently concluded concerning development of the agroindustrial complex also offers a general basis for the appropriate role of research and development in that sector, which has already been established.

Long-range research programs should cover the fields of plant production, animal husbandry and veterinary science, forestry, water management, environmental protection, and then the hilly and mountain zone and the agricultural market; the relevant disciplines should be enlisted in the biological, biotechnical, economic, sociological and other sciences. The importance of ecology and climatology stands out among the natural sciences.

In the food processing industry research should be concentrated on food manufacturing technology within the context of chemical technology. Food technology is one of the priorities in research and development. The food processing industry should be oriented toward higher phases of processing of agricultural products (for example, fully prepared and semiprepared foods) and should adapt flexibly to changes in domestic and world demand for food products (marketing). In this sector we are achieving sizable export benefits on the international market under conditions of free competition (meat and processed meat products), and we can offer great aid to the developing countries in overcoming their initial agricultural structure.

4. Research in the Chemical Industry

In the world today the chemical industry has the position of one of the most propulsive activities. In our country we expect faster development of the organic chemical industry along with the construction of heavy petrochemical facilities. Further development of the heavy inorganic chemical industry is

also needed. The heavy chemical facilities will provide mass production of chemical raw materials used in the diversified production of chemical products. Of particular interest is the production of synthetic materials, synthetic fibers and synthetic rubber.

Further chemicalization of agriculture is a point of support for development of the inorganic chemical industry, which already has sizable facilities and favorable domestic opportunities for larger output and exports.

Reliance on scientific results is becoming extremely important to the potential development of our chemical industry, especially the production of chemical raw materials and manufactures. This applies above all to research in organic chemistry, both pure and applied, which embraces the chemistry of macromolecules and polymer technology with related fields, chemical engineering, and so on. Very large research and development facilities exist in this industry, and alongside the integrated production program, an integral research and development program should be compiled.

In the chemical pharmaceutical industry there is also a need for faster organization of the production of pharmaceutical raw materials on a scientific basis. This industry already has strong R&D capabilities (institutes and laboratories) which are in large measure capable of obtaining their own technological solutions and adaptations, particularly in the production of drugs (antibiotics), though extensively on the basis of foreign raw materials. Here there is a need to link up production and the division of labor among several strong producers, which ought to embrace and advance research and development, particularly with a view to greater orientation toward domestic raw materials.

5. Research in the Electrical Products Industry and Electronics

We should emphasize at the outset that the electrical products industry in general, and the electronics industry in particular, are among the most dynamic sectors of industrial production; on the one hand they are the fastest to absorb the results of scientific discoveries and technological innovation, while on the other they are revolutionizing the means of production in almost all domains of human labor. Its role is growing more and more in the spreading automation of work operations and production processes. Our desire to keep pace with present-day technical and technological progress in the world requires that the electrical equipment industry be given appropriate treatment in the concept of long-range development. Particular attention must be paid to development of professional electronics, whose application is spreading into broader and broader areas.

In all industrial activities facilities will be modernized, new technologies and new types of organization of production will be adopted, materials will be more and more highly concentrated, and there will be data processing. Thanks to the application of computers and data transmission and processing equipment, holographic and laser devices and automatic systems for programming and control it is possible to carry out programs for advancement of

production, of project planning and design, of measurement and monitoring, and so on. Modernization of all the branches of transportation has already become a field for application of professional electronics. Information systems and electronics are also taking over the field of education and health care of the public, especially in diagnosis and prevention. All these needs suggest an exceptionally rapid development of certain sectors of professional electronics.

However, professional electronics cannot develop effectively without a unity of effort. It is indispensable to have self-managed coordination of development programs throughout the country, along with a division of labor which will facilitate deeper penetrations. The development of electronics must be a field for us to make exceptional R&D efforts, and this cannot be done without a pooling of labor and capital and a concentration of specialized personnel.

The electronics industry offers unusually favorable opportunities to our science to make its contribution in creation of a domestic technology. This research extends from the basic sciences, including solid-state physics and semiconductor physics, through applied research in the fields of electronics, cybernetics, and applied mathematics, all the way to diverse research on prototypes of devices, instruments and machines. The drafting of research projects should be entrusted to research organizations in the electrical equipment field, and they in turn must be unified and reinforced on the basis of the coordinated national programs we have mentioned.

6. Research in the Metal Manufacturing Industry

As the producer of means of production, this industry is a vehicle of technical and technological progress. In the coming period it must be thoroughly redesigned on the basis of the orientation contained in a long-range program. The emphasis is on improvement of the production of capital goods and durable consumer goods, fields in which Yugoslav R&D capabilities can be employed to the maximum.

The development of the entire metal manufacturing industry should provide the necessary support to propulsive activities such as electronics, the motor vehicle and motor industry and machinebuilding, and then also the defense industry, the tractor and agricultural machine industry, shipbuilding and the machine tool industry. The production of hydraulic, pneumatic and measuring and regulating equipment is relevant here. Concentration of development and design work through self-management integration of labor and capital is a condition for effective development. Scientific and technical and technological progress must keep pace in the production of equipment and ships and must have an active part in that progress, accompanied by the study of long-term trends in domestic and world investment activity, sales conditions, credit financing, and exports and imports.

In this industry there will be a need for long-range R&D programs in the engineering and relevant natural sciences, as well as in the economic sciences. Here there is the greatest room for application of domestic technology.

7. Research in the Transportation and Communications Field and in Construction

The priority fields of research also include certain research to be done in the transportation and communications field and in the construction sector. Both activities have an active part to play in overall economic development, while at the same time they are areas for a strong penetration of technical progress, modern equipment and up-to-date organization of work.

The need to modernize transportation and telecommunications calls for a joint development policy throughout the country with a view to spatial linkup. The "Basis ..." referred to enumerates the principal problems and lines of development for rail, highway, maritime, river and air transportation, as well as the postal service. Transportation is about to see the application of numerous technological innovations (trains built around turbine locomotives, monorail, "air cushion" watercraft, STOL and VTOL aircraft, etc.). Most of these innovations are still in the phase of experimental development in the world, but preparations should be made for them. In the development of our transportation that has been outlined up to the year 1985 many problems will still have to be solved in transportation engineering and in the global movement of goods and services; research and specialized work organizations should be committed in this area. It is particularly important to keep pace with the application of so-called integrated transportation (containers, pallets, etc.).

In the field of telecommunications--which is an outstanding area for technical and technological innovations--automated telecommunication and information systems will have to be built. There are plans to build a separate data transmission network.

Construction is a sector of particular importance to development policy and therefore to research and development as well. New solutions in construction technology and in substitution of building materials are becoming more and more frequent in this sector. Our institutes have provided very notable and valuable results even in the first phase of the country's construction.

In the tertiary activities tourism has also become part of the framework of Yugoslavia's economic orientation for the coming period, since it is among the small number of propulsive activities (see the "Basis ..."). Although this is not a field where innovation is remarkably important, there will still be a need to devote considerably more attention to studying the economics of tourism, spatial planning, construction of tourist centers and facilities, environmental protection, marketing, and so on. Present research, which is scattered, can be better linked and oriented toward the key questions in the coming period.

The national defense component should be included in research within these priority areas from the technical-and-economic standpoint. The equipping and supplying of our armed forces should be based on domestic production facilities and raw materials.

It is well known that development issues are closely bound up with the issues of the system. It might be said that today every determinant of the new self-management system cries out for a thorough reshaping on a scientific basis. This research area would include economic laws and the production relation of self-management, income of associated labor and its distribution, the self-managed organization of associated labor and social reproduction, the social aspects of associated labor, institutionalization of the self-management production relation at all levels, self-management planning in the market, and so on: in short, the economics of the self-managed Yugoslav economy. Economic institutes have already taken up the questions of the economic system, and their results have provided a substantial contribution in the drafting of public documents and federal laws.

The priority lines of research which have been chosen in the group of technological and economic goals are priorities of Yugoslavia as a whole. The republics and provinces will work on them so as to complement one another, each according to its specific capabilities and specialized interests within the framework of the country's general interest. That means that individually all these priorities are not automatically priorities for every republic and province. Participation ought to be differentiated and complementary, which again need not mean a sharing of priorities among them. Nevertheless, certain possible deviations to the advantage of the less developed regions should still be borne in mind.

Long-range research programs and projects should devolve from development programs at the level of work organizations and then of industrial groupings, industries and the entire economy. Priority research programs are then drafted on that programmatic basis at the interrepublic and federal levels by those commissioning the research and those who will conduct it. But the technical aspects of proposed versions of these programs and projects should be drafted in scientific language by scientists and institutes themselves, whether within the framework of the self-managed special-interest community for scientific work or on the basis of a direct exchange of labor. The rule is that the process be two-way in shaping these programs, i.e., that scientific activity be given definite social assignments, and that it have an active and independent role in the formulation and tactical elaboration of those assignments. Certain experiences elsewhere in the world demonstrate that imposing ready-made and already elaborated programs would lead to failure or an intolerable lag in research and application. At the time when these programs are finally adopted, the assignments being given by society must be the same as the research assignments being offered.

Priority Lines of Research Arising Out of the Social and Humanistic Goals

The priority lines of research within this group of goals are referred to more as relevant subject matter for research which can be shaped when specific programs are being adopted. The general criteria for joint long-range research will be the spatial relatedness of phenomena (for example, domestic migrations of population) or their fundamental social significance (the social system, major social problems). More detailed indications in this respect will be provided by the social development plans of the Federation, the republics and provinces. The essential thing here is to coordinate research and guarantee a comprehensive approach to the study of the phenomena and problems. The role of organizers and coordinators should primarily be played by the republic and provincial communities for scientific work through their joint interrepublic body--the League of Communities for Scientific Work.

Priority lines of research in the social and natural sciences can be derived from a survey of the social and humanistic goals of science policy.

1. General research on the organization and functionality of socialist self-management as a new social system; development of a theory of self-management;

2. The political economy of self-management socialism;

3. The economics of the self-managed Yugoslav economy;

4. Research on social changes related to differentiation of the social structure;

5. Demographic research;

6. Research in the field of health care of the public and social welfare of the working people;

7. Research in shaping the space and community in which man lives;

8. Environmental protection;

9. Conception and theory of nationwide defense.

Most of this research will be done in the social sciences with an up-to-date orientation on the basis of Marxist theory. At the present new disciplines and subdisciplines are being created such as political science, psychology, psychophysiology, social geography, philosophical and social anthropology, ergology, and so on. This branching off and interpenetration of sciences allows for a combined and interdisciplinary approach to the study of complex social phenomena. This will indeed be necessary in many basic studies conducted within this group of goals. It might be said that we have the

personnel for such an approach, but difficulties arise in making up and coordinating mixed teams and groups because of traditionalistic resistance, institutional barriers and personal exclusiveness.

Priority Lines of Research Arising Out of the General Cultural Goals

The general cultural goals of science policy are aimed at the development of science itself and of scientific activity as an organized subsystem, and then at the development of education and the improvement of general culture. This will in turn promote the fulfillment of the technological-and-economic and social-and-humanistic goals.

Science policy is expected to establish the proper proportions among basic, applied and developmental research with respect to development of a country's scientific activity as a whole. It is not possible to set any general proportions in this respect which would be universally applicable. It is felt that every country must balance out that relationship for itself. In small countries there is usually a higher share of basic research. At the beginning science develops within the shelter of the university and around the academy of science as a purely cultural activity. Its application is mainly in education, especially in teaching at the postsecondary level. Later the network of institutes becomes more extensive, independent institutes are established, and then there are institutes and development centers in industry, agriculture and elsewhere. The application of science now spreads to new spheres--physical production and social organization. In our country, with its relatively young science, the share of basic research is still rather high, while applied research is lagging considerably, and developmental research is lagging even more. We should therefore strive for a progressive growth of applied and developmental research without reducing basic research, so that the balance would be established at a higher level and in time we would reach approximately these respective financial proportions--15:30:55. We should emphasize in this connection that developmental research is by far the most expensive. In the United States the respective proportions are 12:22:66 (in 1969), which can be taken as the maximum of developmental application.

However, even this division into three types of research should not be taken overmechanically, nor absolutized. It came about in the effort to obtain certain criteria in financing scientific work, but in practical research it is very relative and difficult to maintain. The individual scientist is in fact inclined, after doing basic work in the early years of his career, to move over into the sector of application in the same field, or even into development. To a considerable extent this division breaks down when a country tries to solve some basic problems in its development by means of research activity. These are those long-range basic research programs which are sketched out along the route of the country's further construction and involve politics, science, planning and the economy, that is, our entire self-management mechanism and associated labor. These programs involve interdisciplinary research in the basic, applied and developmental fields, and

in practical research proportions are established in a sensible and realistic way. Everyone has to do his share of the common task and to grow in the course of it once the public decision has been made. As has been said, science is what men make of it on behalf of the people supporting it.

Science ought to be ahead of practice by a lengthy period of time and should be oriented toward the country's future development. This should be the starting point of what is called goal-oriented basic research, which pursues a specific goal only in some future time. In such institutes research might be initiated on some chosen narrow field within a discipline; immediately applicable results would not be sought, but rather knowledge and skill which would facilitate certain applications when the practical conditions come about for them. For example, a country developing an organic chemical industry must have advanced research and instruction in the fields of organic and macromolecular chemistry, polymer technology and so on. When it comes to agriculture, genetics and related fields are developing in biology. The electrical equipment industry relies through electronics and electronic technology on semiconductor physics as a branch of solid-state physics. These are specialized fields which illustrate how basic research can be oriented toward the country's science and development policies without having to be planned in detail, since that is not even possible for them, but they can be oriented in this sense.

Another important activity, one that in practice is intertwined with the first one, lies in monitoring and absorbing the results of world science, in which basic research is very strong, and at the same time it is an almost gratis source of information. These world results and trends must be assimilated in Yugoslav institutes and laboratories, elaborated, and adapted to domestic conditions and needs. It is easiest to develop international scientific cooperation in this area, since here there are no government and trade secrets, and the costs of cooperation are not great. The very transfer of foreign knowledge, the circulation of scientific ideas over borders, and one's presence in the world scientific community mean a very great deal, even though they do not yield any tangible benefits at first sight. On the other hand, if basic research becomes literally and slavishly tied to foreign models and sources, then it is either useful to them or to no one, and this actually happens. What we need here is for our science to monitor in particular the trend of world priorities in science.

It is characteristic of the present state of the basic natural sciences that their applicative component is also developing, and this is where our science is lagging and deficient. Whereas pure physics and pure mathematics have already developed, we are weaker in applied physics and applied mathematics and cybernetics, which extend in the direction of technical and economic application. (For example, numerical analysis in mathematics is related to the engineering of electronic systems; new mathematical methods, econometrics, linear analysis and so on are being used in the economic sciences.) A similar deficiency also shows up in other scientific disciplines, and development of the relevant research is taking on priority importance in

this group. A certain reorientation has already been felt in recent years. That basic research which is not developing just one scientific discipline or field, but several of them (solid-state physics, for example) should be given a type of priority.

As we said in surveying the general cultural goals, within a certain radius these goals are free of the other goals, since they tend toward creation of the general theoretical underpinning of knowledge and application. Science also has its own specific goals. Basic research is the reproductive organ of the entire scientific system, that element which becomes the origin of application through its creation of new knowledge. Basic research is becoming an integral part of the experimental process. In this area there should also be help from free research, especially in established institutes. It will be a contribution to the general fund of knowledge and will not allow scientific thought to fall into neglect. This would include what is called exploratory research, as distinguished from exploitative research. This research, incidentally, does not require large amounts of money.

Our universities and academies of science have an important function in the policy governing basic research and in its orientation.

More detailed priority in this group of goals goes to what are called the national sciences, which, by contrast with sciences that have universal and international scope, take as their subject matter our own geographic region--the Yugoslav or even Balkan region in terms of space, and the history and culture of the Yugoslav peoples in terms of time. Through them our peoples become conscious of themselves, of their existence in time and space, of nature, of society, of their position in world culture. They illuminate the space-time dimension of our existence.

Being domestic sciences, they naturally were the first to develop, and it might be said that our country has been scientifically studied to a large extent, but there are still considerable gaps and projects which have not been completed. This is subject matter for what is called basic descriptive research. It is certain that all such exact descriptions (flora and fauna) and measurements (for example, our Adriatic coast has still not been accurately surveyed from one end to the other) have still not been made. We do not yet have complete large maps--geological, botanical and pedological, maps which some countries smaller than ours already have. With respect to minerals and ores it is likely that there are quite a few gaps in our knowledge and concealed resources in this entire complex.

The national sciences oriented toward the study of our own space and subsurface might also include the following: the biological sciences--anthropology, zoology and botany; geography--both natural and social; geology and mineralogy and hydrology; geophysics and meteorology, seismology; oceanography and marine biology (Adriatic Sea); geodesy and cartography; spatial planning as a multidisciplinary field.

Research is and will be conducted in these disciplines mostly for the respective areas of the republics and provinces. Joint long-range research should be organized wherever and insofar as there is a pronounced spatial relatedness and an adequate common interest. These might include the following long-range programs and projects:

1. Research in the field of geology and mineralogy of importance to Yugoslavia as a whole;

2. Research on Yugoslavia's hilly and mountain zone;

3. Research on the large river watersheds and the entire field of water management;

4. Research in the field of meteorology;

5. Research in the field of seismology;

6. Research in the fields of the oceanography and marine biology of the Adriatic Sea;

7. Spatial planning of Yugoslavia;

8. Preparation of large maps--geological map, botanical map, pedological map of Yugoslavia, along with certain specialized maps.

Some of these research programs have particular importance to our armed forces and to nationwide defense as a whole.

The group of national sciences also includes humanistic or cultural-and-historical sciences oriented toward our country. These would be history, philology, ethnology, archeology, the history of art, the history of philosophy, and then certain subdisciplines such as Slavic studies, Old Church Slavic language and literature, Balkan studies and Byzantine studies. They will also develop within the republics and provinces, but joint long-range coordinated research might include major synthetic works in the history and culture of the Yugoslav peoples, certain large research subjects, basic scientific aids and manuals, scientific encyclopedias, large dictionaries, general scientific bibliographies, basic anthologies of materials, and so on.

Over the long-range period up to 1985 certain major scientific works ought to be completed if possible, namely:

1. History of the Nationalities and Ethnic Minorities of Yugoslavia;

2. History of the Yugoslav Working Class Movement;

3. History of the Philosophy of the Peoples of Yugoslavia;

4. Linguistic Studies of the Languages of the Nationalities and Ethnic Minorities of Yugoslavia;

5. History of the Literature of the Nationalities and Ethnic Minorities of Yugoslavia;

6. History of the Art of the Nationalities and Ethnic Minorities of Yugoslavia;

7. Archeology of Yugoslavia;

8. Ethnological Atlas of Yugoslavia, With Monographs;

9. Folk Art of Yugoslavia.

Partial studies in this domain are under way in the republics and provinces, and when the time is right, they should be brought together for synthesis through coordinated interrepublic projects, and they should be given the final form of presentable publications.

The cultural goals of science policy also extend to a study and scientific contribution in development of the sphere of upbringing and education. Establishing a programmatic link between scientific research and education is an essential condition for enhancing their social functionality. To this end the institutional basis of the pedagogical sciences should be bolstered, since it could carry on important research in a framework of mutual coordination with the relevant specialized institutions.

Certainly the priorities covered by this group of goals should also include creation of scientific information systems. An up-to-date information system is an indispensable condition for effective research in any field of science. Since it is relatively new, development of information science, and particularly the development of up-to-date methods and techniques, has not kept pace with the overall development of scientific research. Realization that organization of an information system in science is a precondition for research and development has not yet established broad roots in our country. Organizational and financial steps should therefore be taken to stimulate demand for scientific information and for pooling arrangements in the use of information services. The national information network might be linked to the international system UNISIST.

Referral centers in the republics and provinces should, it is thought, be the basis for the information system. All existing sources of data and primary information would be recorded in these centers, so that information would not only be gathered, but would also be processed and screened. Information centers for specialized areas would be set up depending on the concentration of users (industry, universities, scientific institutes), the level of development and activity of existing documentation services and libraries, and the capacity of the network of electronic computers and telecommunications.

Data transmission by means of "data bases" is among the principal tasks of present-day information science. "Data bases" are organized collections of information devised in information centers, both domestic and foreign, and purchased on magnetic carriers. They would include central catalogs of books and periodicals, patent documents, standards, research and development reports, dissertations, as well as all the conventional means of storing and transmitting information.

The subsequent phase of construction would consist of connecting scientific institutions to the information system, division of labor and responsibility, and obligations on the part of scientific institutions to play an active part in developing various forms of information activity. The transfer of information from science to the economy and in the opposite direction is especially important; this should speed up the process of incorporating science into events in the economy and economic development.

Thanks to the spread of information by means of the very effective contemporary methods and techniques, much is done to prevent erection of barriers in various structures, manipulation of research results, the maintenance of particularistic positions, elitism and technocracy. Thus an information system even exerts an impact on the further development of self-management as a whole.

Realization of the present-day conception of the development of information science and an information system in science requires larger investments in this activity along with a number of exemptions in customs, tax and other regulations.

3.3. Survey of Trends and Possible Achievements in World Science

In outlining long-range research policy one should know not only the main lines of the country's socioeconomic development, but also the main lines of world scientific and technological development in coming decades. The methods of scientific forecasting--and also with the help of one of the youngest fields of science, futurology--make it more or less possible to see those points at which science can make substantial breakthroughs in the foreseeable future. Since application time is becoming shorter and shorter, we can expect that these scientific inventions will continue to become technical innovations at a rapid pace.

For the purposes of this document we need to limit ourselves to a short survey of these possibilities in the world literature, but in subsequent activity related to science policy a more detailed examination of trends should be undertaken from the standpoint of our science's development. It is certain that these important breakthroughs will be made in the environments and countries where science and technology are most highly developed. However, our science must take care that it not be caught unprepared, since it can also make its contribution in those fields, contributions which will arise out of the elements of our own environment.

Futurological vision of possible achievements in science and technology up to the end of this century revealed many fields of new discoveries and new application. Systematic research will be conducted in this direction within the principal natural sciences: physics, chemistry and biology, as well as in mathematics, and then also in the medical and biotechnical (agricultural) sciences, along with the relevant technical and technological research. The coming period should also see intensification of research in the social sciences, in psychology, pedagogy and pedagogical technology, in various sectors of engineering, in the specialized fields of information science, telecommunications, aeronautics, and so on.

In physics, for example, a number of lines of research are taking on exceptional importance in the field of structural physics. Closely related is applied research in the field of a number of semiconductor and other dispositives. In the chemical discipline great attention is expected to be paid in coming years to development of apparatus for analysis and measurement. There will be ever greater use of computers linked directly to instruments for analysis and measurement which will be able to directly compute their results. Great attention will be paid to research in structural chemistry--the study of structures of those materials used in industrial production, particularly the new ones on whose synthesis chemical science is doing a great deal of work. Research in organic chemistry is aimed at obtaining new polymers (thermostable, semiconductor, etc.), new plastics, new ceramic materials, and so on. In electrochemistry particular attention will be paid to the study of energy conversion processes and consequently to creation of new sources of electric energy as well.

Research on materials of different kinds (the science of materials) has great prospects.

In the coming period new lines of research and development are expected in the direction of new products in the field of household appliances and professional electric equipment, especially in the field of computer equipment. This is all the more the case because coming decades are supposed to result in extensive computerization and automation of the most widely differing areas of production and general social use (microcomputers, for example).

This research will lead to intensification of research in the field of information science, specifically for documentary, medical, pedagogical and other information.

One can expect an exceptionally rapid progress in the new type of hardware and software, in what is called the interface, which makes it possible to link computers and measuring instruments for analysis and thus to achieve very rapid collection and interpretation of data.

In the long-range period ahead of us research is also expected to become more intensive in the fields of biology, especially in biochemistry, biophysics and molecular biology. Research will be centered on cell structure,

cell growth and development, the mechanism of inheritance and other problems. This research should make a contribution to related research in the medical and biotechnical sciences, to oncological research in medicine, and to a substantial increase of yields in plant production and animal husbandry.

Other present-day research is also aimed at increasing yields in agriculture; here we might mention the use of infrared photography from airplanes or satellites for long-distance measurement. This research offers the possibility of assessing the capability of various locales for a particular crop and of making a precise estimate of the possible yield. This method also facilitates early detection of plant disease. Research will continue on pesticides. Long-distance measurement can also be used effectively in geological exploration, in finding new deposits of various minerals, petroleum, and so on.

Research in the medical sciences will be developing rapidly, especially in the fields of oncology, immunology, cardiology, geriatrics, preventive social medicine, the study of congenital illness, creation of artificial organs and prostheses, automation of health services, and so on, while in pharmacology research will be focused on creation of new and very effective drugs.

As we have said, in coming decades we should expect information science to develop very rapidly and to become linked with various forms of productive, business, scientific, educational and other activities. Research is very promising in the development of pedagogical technology--development of teaching with computers and development of audiovisual instruction.

A large expansion of research is expected in the field of automatic documentation systems--in the creation of data banks and links between them, in the creation of systems for selective dissemination of information, and so on.

New directions in combating pollution can be expected in coming years. In combating water pollution intensive research will be done on the problem of treating sanitary sewage, the problem of treating and controlling industrial effluents, improvement of methods of measuring the effects of pollution, the problem of treating solid waste, the question of dumping treated and untreated waste into lakes, estuaries and seas, and so on. In the field of air pollution control research efforts will be directed toward development of systems capable of reducing carbon monoxide and hydrocarbon exhaust gases from internal combustion engines and the creation of new types of motor fuel.

After a certain lag new breakthroughs are expected in peacetime use of nuclear energy ("breeding" for nuclear power plants), all the way to its general application in the foreseeable future. Lasers and masers will be put to many uses.

An important advance is expected in research in the fields of psychology related to biology (the study of nerve cell structure and of processes within

nerve cells), which will lead to important innovations in medicine and pharmacology.

New lines of research should be expected in the field of meteorology toward obtaining precise weather forecasts, and then in the field of seismology (earthquake prediction), in the field of oceanography (food from the sea), and so on. But at the same time humanity will confront phenomena such as biological warfare, the neutron bomb, and so on.

3.4. The Bases of Science Policy and Balanced Development of the Republics and Provinces

The goals of science policy concerning the balanced development of the republics and provinces and the faster development of the less developed regions will follow the line of joint policy governing Yugoslavia's long-range development. Scientific activity will in part be conducted on the basis of cooperation and coordination among the republics and provinces, and within that there will be a place for joint promotion of that activity in the underdeveloped republics and in the Province of Kosovo.

As emphasized in the "Basis ...," which we have referred to, the policy governing faster development of the underdeveloped regions and of gradual reduction of differences in level of development is among the priority tasks in Yugoslavia's long-range development policy. The level of development of our economy tolerates physical disproportions between regions and industries with ever greater difficulty. The country's long-range development is based on a restructuring of industry, on utilization of domestic sources of raw materials for industrial purposes, and the underdeveloped regions possess important natural and mineral wealth. There will thus be increased exploitation of these natural resources, the relevant industry and infrastructure will develop, and so on. In the economy this will involve broader and more direct cooperation among work organizations from the advanced and less developed regions in making joint investments and in applying knowledge and present-day technology and organization of work. Moreover, aid will continue to be extended to those regions from the federal budget through the special fund.

In this general situation, in those regions priority importance will be given to achievement of the technological-and-economic and general cultural goals of science policy in the coming period. This means that an effort should be made toward an ever greater contribution of science to developing physical facilities and also to the development of activity itself in science, education and general culture.

In the science policy of the less developed regions priority should at present be given to the training of their own scientists. With regard to institutional facilities, as a rule it is sufficient to establish a limited number of scientific institutes and development centers of ample strength. As a general orientation it would be worthwhile that theoretical research should

organizationally be linked primarily to the universities and academy of sciences, while applied research would be done in relation with the economy. The future establishment of independent institutes, which is a sign of a higher level of development, should be gradual and cautious, in line with the region's overall development. The less developed regions have an opportunity to take advantage of the experiences of the more advanced regions in building up their scientific structure and to avoid the errors which were made there.

As for the research programs, they ought to be oriented toward still narrower priorities important to their own development, while at the same time they should steadily raise the quality of their work. Their priorities might at the same time be complementary in the sum total of all research (for example, in seismology, in metallurgy, etc.). With respect to financial funds for scientific activity, it is felt that in these regions they ought to grow at an annual rate higher than the Yugoslav average. The evident progress made so far in all fields of scientific activity in the less developed regions will make it possible for those funds to be assimilated rationally. It is expected that these regions will have a higher growth rate of the social product than the average rate for the entire country, which is to be established in the social plans governing Yugoslavia's development.

The more advanced republics and provinces have already been offering rather broad aid to the less developed regions in their scientific activity, although that aid perhaps has not been systematic enough, and here and there there have been admixtures of paternalism. The League of Self-Managed Special-Interest Communities for Scientific Activity in the SFRY, as an interrepublic organ, should always have this component of aid and solidarity in mind during joint actions, and in the final analysis it will be of benefit to everyone. At the same time, the communities from the less developed regions might find that they have an interest in broader actions which are raising our science as a whole. A great deal might be done toward advanced training and specialization of scientists from those regions in the renowned centers all over the country, without having to send these people abroad in every case. Yet there ought to be greater mobility of experienced scientists in the other direction. In a certain number of major research projects fruitful research cooperation has already been established (for example, in the economic sciences), and in future it could be expanded still more, and in some projects individual centers could even now take a leading role (for example, seismology and earthquake engineering). Cooperation should also be expanded outside institutional frameworks, within the activity of scientific societies, the holding of scientific congresses, the printing of scientific publications, information activity, and so on.

The general problems related to the faster development of these regions, problems like the exploitation of mineral raw materials or improvement of the hilly and mountain zone, deserve a place in the research programs of all republics and provinces because of their broader importance. General and

specialized studies should also be conducted as a way of paying particular attention to the principal problems of the less developed regions.

The impact of scientific activity should, moreover, be more strongly manifested in the improvement of education, especially the quality of higher education, as well as an improvement of general culture in those regions.

These propositions will be elaborated in greater detail when joint research projects and other joint activities are defined in the context of the specific priorities of the less developed regions of Yugoslavia.

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